MASTER'S THESIS

Making Use of Students' Usage and Perception Information to Improve Online Learning Activities: A Dashboard Design Founded on Teachers' Needs.

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Making Use of Students' Usage and Perception Information to Improve Online Learning Activities: A Dashboard Design Founded on Teachers' Needs

Gebruiks- en Ervaringsinformatie van Studenten Benutten voor de Verbetering van Online Leeractiviteiten: Een Dashboard Gebaseerd op Docentwensen

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Summary

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Nowadays online learning activities in higher education are common. Teachers at Hogeschool Windesheim receive, in contrast with face-to-face activities, little feedback on students' use and perception of online learning activities, leaving them with insufficient information to improve those activities.

Introduction of log data from Learning Management Systems has expanded the collection of student-data enormously, however there is little evidence that learning analytics are deployed widely in higher educational practice. Besides that, few have actually asked the question what kind of data would be valuable to analyse (Viberg et al, 2018). Ifenthaler (2015) calls on higher education institutions to analyse and create new interventions and actions based on LA. Related work has shown teachers' interest in a wide variety of usage information and students' willingness to provide feedback (Schmitz et al. 2018). Few studies asked teachers what would help them to enhance their work, even though starting from teachers' needs is key to create support for the use of LA-tools.

This study aims to identify what information teachers need to be able to improve their online learning activities and to design and evaluate a dashboard that presents data to teachers. In a mixed method design a self-composed survey was distributed to 773 teachers at the institute of higher education Windesheim (n=77). The survey identifies the learning activities currently used and teachers' needs for information on students' (a) use and (b) perception of these learning activities. Using the results of the survey a mock-up prototype was designed using a data-visualisation program called Power Bi. A first and a second prototype was each introduced to 5 teachers who were observed while using it and an evaluation was done with semi-structured questions and the Evaluation Framework for Learning Analytics (Scheffel et al, 2017).

Results from the – not generalisable - survey showed that the four most used learning activities are reading texts, videos, formative assignments, and lectures. On students' use respondents mostly would like basic information on how often links to texts and videos are used, assignments are submitted, and lectures attended. Besides that, even more respondents would like information on how students perceive the learning activities. The preferred method for collecting this perception information is through questions collecting free text answers. In fact, 90% of respondents would use a dashboard with this information.

Results from interviews on the first prototype show that interviewees are enthusiastic about the dashboard and suggested adding effectivity measures such as test results and further clarification on how data was collected. Interviews on the second prototype again bore enthusiastic interviewees and suggestions for two improvements: The first one on using a better technique to show test-results and the second one to add cross-connections per student (still anonymously) to be able to value remarks and reviews. Finally, evaluation (EFLA) shows a score of 74.1 for the second prototype. An average score of 9.2 on "This dashboard makes me aware" and "This dashboard stimulates me to adapt my learning activities" supports the use of such a dashboard for improving learning activities.

Learning Analytics- dashboard design- teachers' needs - learning activities - higher education

Samenvatting

Gebruiks- en Ervaringsinformatie van Studenten Benutten voor de Verbetering van Online Leeractiviteiten: Een Dashboard Gebaseerd op Docentwensen

L.M. ten Den

Tegenwoordig is het gebruik van online leeractiviteiten in het hoger onderwijs standaard. De docenten bij Hogeschool Windesheim ontvangen echter nog weinig feedback over hoe studenten online leeractiviteiten gebruiken en ervaren, dit in contrast met fysieke leeractiviteiten. Docenten krijgen daardoor onvoldoende informatie om de leeractiviteiten aan te scherpen.

Het bijhouden van datalogs in Learning Management Systemen heeft geleid tot een grote hoeveelheid studentdata, maar er is weinig bewijs dat de analyse en het gebruik van die data breed wordt ingezet in het hoger onderwijs. Daarnaast is er nog weinig onderzoek gedaan naar welke data waardevol is om te analyseren (Viberg et al., 2018). Ifenthaler (2015) doet een beroep op het hoger onderwijs om nieuwe interventies en acties te analyseren en creëren op basis van LA. Aanverwante studies tonen de behoefte van docenten aan veel en diverse data en de bereidheid van studenten om hun data te delen (Schmitz et al, 2018). Er zijn weinig studies waarin docenten gevraagd is wat hen zou helpen hun werk aan te scherpen, terwijl het starten bij de behoeften van docenten essentieel is om draagvlak voor het gebruik van LA-instrumenten te creëren.

Het doel van deze studie is te onderzoeken aan welke informatie docenten behoefte hebben om hun online leeractiviteiten aan te scherpen en een dashboard te ontwerpen en te evalueren waarin deze data aan docenten wordt gepresenteerd. In een mixed-method onderzoeksopzet is een zelfontworpen survey onder 773 docenten van hogeschool Windesheim uitgezet (n= 77). De survey inventariseert de gebruikte leeractiviteiten en de behoeften aan informatie qua (a) gebruik en (b) ervaring. Met de resultaten is een mock-up prototype ontworpen in het datavisualisatie-programma Power BI. De eerste en tweede prototypes zijn ieder in individuele online-afspraken aan 5 docenten getoond die tijdens het uitproberen werden geobserveerd; voor de evaluatie werden semigestructureerde vragen en het Evaluatie Framework voor Learning Analytics (EFLA) (Scheffel et al., 2017) gebruikt.

Uit de resultaten van de - niet-generaliseerbare - survey blijkt dat leesteksten, video's, opdrachten en colleges de vier meest gebruikte leeractiviteiten zijn. Respondenten willen qua gebruik vooral weten hoe vaak studenten de link naar de teksten en video's aankiezen, opdrachten inleveren en colleges bijwonen. Opvallend is dat meer respondenten informatie willen over hoe de studenten de leeractiviteiten ervaren. Voor het verzamelen van deze ervarings-informatie bij studenten gaat de voorkeur uit naar open reactiemogelijkheden. Meer dan 90 % van de respondenten geeft aan een dashboard te willen gebruiken.

Uit de interviews over het eerste prototype blijkt dat geïnterviewden enthousiast zijn en tegelijkertijd suggesties doen voor het toevoegen van effectiviteitsmetingen zoals toetsresultaten en betere uitleg over hoe de data is verzameld. Bij het tweede prototype blijkt de noodzaak voor een andere techniek om de toetsresultaten te tonen en het onderling koppelen van de opmerkingen/reviews en de inspanningen en toetsresultaten zodat deze op waarde kunnen worden geschat. Tot slot kijkend naar de evaluaties toont de EFLA-meting een score van 74.1. Een gemiddelde score van 9.2 op "Dit dashboard maakt me bewust" en "Dit dashboard stimuleert me om mijn leeractiviteiten aan te passen" pleit voor het gebruiken van een dashboard voor het aanscherpen van leeractiviteiten.

Learning Analytics- dashboard design - docentbehoeften – leeractiviteiten – hoger onderwijs

1. Introduction

At Hogeschool Windesheim (HW), a higher education institution (HEI) in the Netherlands, teachers frequently express having little insights in how students interact with online learning activities (LACs) and not knowing whether these activities contribute to student needs. Currently online learning environments (OLEs) provide little access to information about how students interact with the online LACs. Information comes from students' self-reports on their *use* and *perception*, e.g. after-course-evaluation surveys and face-to-face-evaluations. These mainly collect general information and are famous for their "can't remember" responses. They are not well-suited for collecting sufficient details for improving online LACs during course runtime. In contrast teachers receive real time data on quite a few other aspects of their work, e.g. rates on enrolment, drop-out or study start evaluations offered to them by Power Bi, a data visualisation program. Teachers at HW thus express they would like more relevant and timely information about their students' interactions with and perception of the online LACs.

Deployment of usage information from OLEs to enhance learning is studied in the field of Learning Analytics (LA) (Siemens, 2013). A substantial amount of LA-studies has been done over the past 10 years and a high potential for improving learning support and teaching was identified. Yet, little evidence was found that this potential has transferred into higher education (HE) practices (Viberg, Hatakka, Bälter & Mavroudi, 2018). Deployment of usage information in higher education is not yet common, even though some work has shown teachers' interest in a wide variety of usage information and students' willingness to provide feedback (Schmitz, Scheffel, Van Limbeek, Bemelmans & Drachsler, 2018a).

In a specific line of research, LA focuses on alignment with Learning Design (LD) (Conole, 2012) which comprises online learning activities. Usage information retrieved from an OLE could be deployed as input for teachers to improve online LACs (Laurillard & McAndrew, 2002, March; Mishra & Koehler, 2006; Shattuck & Anderson, 2013), yet few studies have been done to understand what usage information teachers would need for data-driven decision making in improving LACs (Viberg et al., 2018). Concerning students' perceptions on learning activities no studies were found, but Dooms, De Pessemier & Martens (2011) used feedback systems to monitor interaction of users. In a study on monitoring course design (Schmitz et al., 2018a), results show a diverse range of 30 LA-requirements teachers mention, e.g. "participation in learning activities", "usage of learning materials" and "the quality of learning materials", these are in their study not further specified or deepened.

Many of the LA-LD studies focus on developing learning analytics dashboards (LADs) and almost all aim at influencing students,- either directly or through teachers- trying to raise learning awareness or changing study behaviour (Arnold & Pistilli, 2012; Verbert, Duval, Klerkx, Govaerts & Santos, 2013; Schwendimann et al., 2017; Bodily, Ikahihifa, Mackley & Graham, 2018; Bodily et al., 2018;

Viberg et al., 2018). Most LADs still follow the traditional paradigm in which the teacher is the main user monitoring students, state Schwendimann et al. (2017).

LAD-design has been studied widely as well. Many studies look at how information can be presented in dashboards (Duval et al., 2012; Park & Jo, 2017; Schwendimann et al., 2017; Sedrakyan, Mannens, Verbert, 2018; Vieira, Parsons & Byrd, 2018; Yoo, Lee, Jo & Park, 2015). In their 2017 review, Schwendimann et al. state that a rich variety of indicators is being used, but comparatively little work has been done on comparing which indicators (and which visualisations) are most suitable.

In this study we narrow our scope to the current (pedagogical, technological) context teachers of Hogeschool Windesheim work in. Starting from their perspective, the focus is on the information they request. Not within the scope of this study are general LD choices teachers make, nor how they fit LACs in educational concepts. The aim of this study is to identify teachers' needs on information and to design a mock-up LAD for teachers that supports improving LACs.

1.1 Theoretical framework

Siemens (2013, p.1382) defines Learning Analytics as "the measurement, collection, analysis and reporting of data about learners and their contexts, for purposes of understanding and optimising learning and the environment in which it occurs". Learning Design is defined by Conole (2012, p.121) as "a methodology for enabling teachers/designers to make more informed decisions in how they go about designing LACs and interventions, which is pedagogically informed and makes effective use of appropriate resources and technologies." Data on student behaviour can be used to indirectly infer whether a LAC needs to be adapted or not. A Learning Analytics Dashboard is described by Few (2006, 2013) as a display that visualises information in a way that the user can make sense of the data at a glance. We follow these definitions in our study.

The Design Cycle for Education (DC4E) (Scheffel et al., 2019) has primarily been created to support the shift from traditional face-to-face education to blended learning scenarios. Figure 1 shows this cycle consisting of four phases that each contains two steps: Identify: 1) goal and 2) challenge; Combine: 3) inspiration and 4) analysis; Realise: 5) development and 6) prototype; Investigate: 7) evaluation and 8) adaptation. Centred in the model the concept of reflection stands for a continuous process of critically looking at and reflecting on the results of each the eight steps.

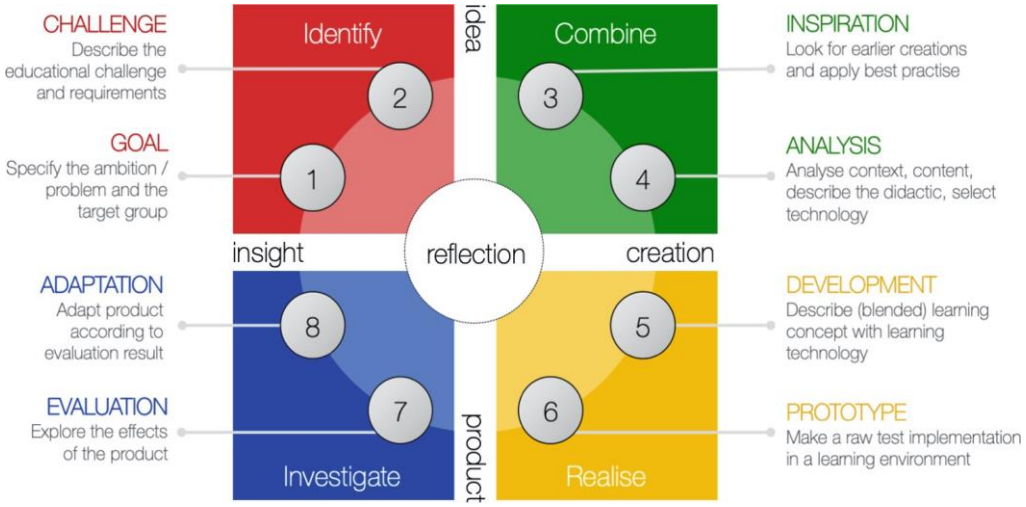

Figure 1. Visualisation of the eight steps of the Design Cycle for Education (DC4E). From "The Means to a Blend: A Practical Model for the Redesign of Face-to-Face Education to Blended Learning," by M. Scheffel et al., 2019. Copyright 2019 by Springer Nature Switserland AG.

The concept of "improving LACs" as used in our research aim, contains all steps of the cycle. Specifically, in step 7) evaluation a LAD with timely and factual information is welcomed, as depicted in Figure 2, in addition to after-course-evaluation surveys and face-to-face evaluations.

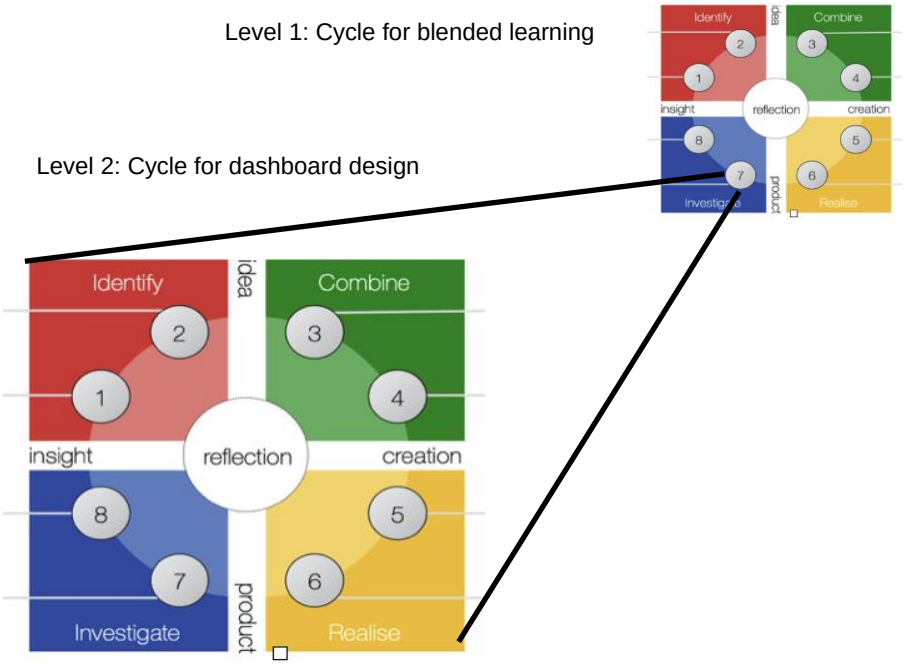

Figure 2. The Design Cycle for Education (DC4E) on two levels: Level 1, the cycle for blended learning design in which in step 7 a tool for evaluation is built by using the DC4E on level 2. Adapted from Scheffel et al. (2019.

Actual changes in the design of LACs in the OLE can be placed in step 8) adaption. The concept

of reflection creates an iterating loop to all other steps to keep the design aligned. Even though the DC4E has primarily been created for LA-inclusive blended LD, in this study DC4E will be applied on a second level- as a cycle for LAD design.

Identify

To start the LAD design, we state its purpose: visualising information about online LACs as input for making more informed decisions on the design of those LACs. The information provided on the LAD can be used by teachers to redesign LACs (Ez-Zaouia, 2020; McKenney, Kali, Markauskaite & Voogt, 2015). The LAD is thus meant for teachers to become aware of the students' current behaviour, reflect about it, make sense of it, and then have an impact on the teachers' LD (Verbert et al., 2013).

Teachers are essential in online learning (Laurillard & McAndrew, 2002, March; Mishra & Koehler, 2006; Rienties, Herodotou, Olney, Schencks & Boroowa, 2018). Online real-time information about how, where, and when students study is available to them (Jivet, Scheffel, Specht & Drachsler, 2018; Schwendimann et al., 2017) and this may help them to fine-tune the LD (Rienties et al., 2018).

Technological knowledge and skills are required to be able to design LACs and use a LAD effectively (Mishra & Koehler 2006). Since teachers are key users of the LAD, it is key to design a user experience for them: starting from users' point of view and researching their needs according to User Centered Design (Norman, 1986; Still & Crane, 2017). What we need to identify is which LACs teachers most frequently use in their designs and what usage - and perception information they need and combine that with what is already known.

Combine

In this study learning activities are defined in line with definitions used by the Accreditation Organisation of the Netherlands and Flanders (NVAO): Learning activities are tasks designed by teachers to support students to attain, realise and demonstrate learning outcomes. Learning outcomes describe what a student is supposed to know, understand and be able to apply after a certain period of learning (NVAO, 2015, p. 6).

LACs can be grouped in many classifications (Laurrilard & McAndrew, 2002; Harris, Mishra & Koehler, 2009). One of the least complex is a didactical framework for the design of blended learning arrangements by Kerres and De Witt (2003). Their 3-C model as shown in Figure 3 distinguishes three components: (a) a content-component, in which learning materials are made available to students, (b) a communication-component that offers interpersonal exchange between students and between student and teacher, both ways, and (c) a construction-component that facilitates and guides individual as well as collaborative learning activities to actively operate on learning tasks.

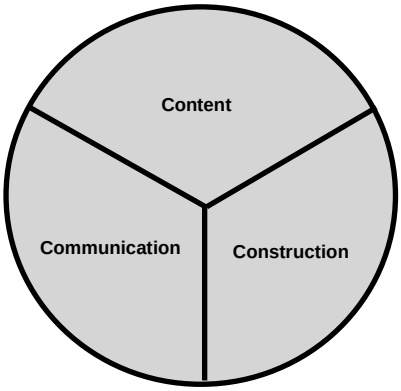

Figure 3. Adapted from "A didactical framework for the design of blended learning arrangements" by M. Kerres and C. De Witt, 2003, Journal of Educational Media, 28, p.101-114. Copyright 2003 Journal of Educational Media.

LACs are embedded in a course design which can to a greater or lesser extent be based on clear-cut educational concepts, the same is true for LADs as Jivet et al. (2017) describe. Bodily et al. (2018) on the other hand in their LAD-design-study chose for a practice-centred approach (Wilson, 2013). They use an eclectic approach of learning theories and instructional strategies they believe will improve student learning based on their experience in practice. The 3-C model allows for serving a variety of educational concepts, which seems also appropriate since HEIs attend to diverse student populations, a broad spectrum of subjects and courses built on multiple theoretical foundations.

Information from students could be collected implicitly (e.g. via data logs) or explicitly (e.g. via surveys or interviews with students). Implicit usage information could be retrieved from learner activity automatically logged in the OLE, i.e., while students interact with one another, the teacher, and the online course materials on the platform (Bodily et al., 2018). Actions such as clicks and text input are logged on time, place, frequency and so on. In a systematic review on LADs Schwendimann et al. (2017) categorise six types of data sources:

> (1) Logs used to track computer-mediated user activity, (2) Learning artefacts used or produced by the users (e.g., analysis of their contents), (3) Information asked directly from the users for analytics purposes (including questionnaires and interviews), (4) Institutional database records, (5) Physical user activity (tracked with physical sensors) and (6) External APIs (for collecting data from external platforms) (p.33).

Collecting and analysing usage data automatically brings up the issue of ethics and privacy (Jones, 2019). Students might be at risk of having their data (and thus their behaviour) analysed without their consent or giving their consent not knowing exactly what they agree to. The more access to information an institution has, the higher the institutions responsibility is to use this information in a sensitive

and ethical way (Greller & Drachsler, 2012). The General Data Protection Regulation (GPDR) (European Union, 2018) offers a legal framework on data protection and privacy in the European Union. Even within this framework institutions could base analytics systems on "fulfilling contractual obligations". However, they can choose to discuss data ownership and ask students for "informed consent", which implies that this consent could be withdrawn any moment and the student has a right of access, rectification and erasure, can object to automated decisions and other rights as stated in the legal framework. Schwendimann et al. (2017) state that "learners should be made aware that their learning traces are being captured and analysed as well as by whom and for what purpose this information is used" (p.35). On this matter Prinsloo, Slade, & Khalil (2019) state firmly that HEIs ought to consider issues such as the need for transparency (of purpose and scope) and the provision of some element of student control.

Explicitly retrieved usage information registers students' perception of LACs, it is optionally and intentionally provided when asked for in a feedback system (e.g. thumbs up or thumbs down or a smiley-scale). Collecting this feedback mostly translates to asking users to rate an item they have just consumed (downloaded, viewed etc.) state Dooms et al. (2011). Students might miss or ignore requests that might be distracting or inconvenient. However, when asked, students report they are prepared to help reflect on LACs and provide data on the difficulties they experience, the task value, the quality of the learning material (Schmitz et al., 2018a).

Several different explicit feedback systems can be used: In a unary system a user can either click on a "like" button or neglect it; a binary system lets the user choose between two options, e.g. thumbs up/thumbs down. A three-point scale offers three options often in red, amber, and green colours in either traffic lights or smileys. A five-point scale has five alternatives e.g. star rating or Likert-scales (Nobarany et al., 2012). Also, a continuous scale can be used, where a slider is to be moved between -10 and + 10. A summary of these variations is shown in Table 1.

Table 1

D*ifferent Types of Feedback Systems Used to Collect Explicit Usage Information*

Feedback systems	Examples
unary	"like" or "favourite"
binary	thumbs up/down
3-point scale	smileys or traffic lights
5-point scale	stars or Likert scale
continuous scale	-10 to + 10

Note. Adapted from "The Design Space of Opinion Measurement Interfaces: Exploring Recall Support for Rating and Ranking" by S. Nobarany et al., 2012, *CHI'12*, May 5–10. Copyright 2012 by CHI'12.

Concerning the pedagogical context for this study HW works on a common organisational strategy with an ambition in creating "personal, challenging and flexible study routes"; a common LD is not in place, decisions on LD are left to the team-, subject- and even teacher-levels. Teachers at HW do serve various categories of students in separate courses, e.g. young adults in full-time (FT) courses and professionals (between 25 to 70 years) in Lifelong Learning Courses (LLL). They might have separate needs on information for both groups, since learner characteristics, learning outcomes and learning designs differ. In the technological context in line with the strategic ambition a Digital Campus is created to realise information-driven organisation to be able to work student-driven. One of the instruments used is a data visualisation application called Power BI, a software service run by Microsoft that can process data from several sources, can present data in real-time and lets a user interact with the visuals e.g. zoom in, combine or filter.

Realise

To make implicit and explicit usage information available to teachers, visualisations need to be designed. When designing a LAD and visualisations we can built on expert knowledge of numerous studies (Duval et al., 2012; Park & Jo, 2017; Schwendimann et al., 2017; Verbert et al., 2013; Vieira et al., 2018; Yoo et al., 2015). Fortunately, Schwendimann et al. did a large review study and identified what different stakeholders find meaningful and how data can be presented to support sense-making processes. In their work they categorise six types of indicator groups:

> *Learner-related indicators* present information describing the learner(s). *Action-related indicators* present information about the actions performed by the learner(s), usually in an aggregated form. *Content-related indicators* provide information about the content that the learner(s) interacted with or produced. *Result-related indicators* give information about the outcome of learners' activities. *Context-related indicators* provide information about the context where the learning took place. *Social-related indicators* show how learners interacted with others. (Schwendimann et al., 2017, p. 34).

Finally, Schwendimann et al. (2017) also ranked different types of visualisations according to their usage frequency. At the top of the list are bar chart, line graph and tables. These visualisations can be used for both the implicit and the explicit usage information. Designing visualisations and constructing a LAD that makes sense at a glance, has its own field of expertise. In his book *Information Dashboard Design: Second Edition* Few (2013) describes best dashboard practices in detail and with a variety of examples.

Investigate

In the last phase of the DC4E, Investigating, the effect of the design is key. Jivet et al. (2018) focus in their review study on how evaluations relate to the purpose of the LAD and find that few LAD designs are evaluated according to their purpose. Scheffel et al. (2017) introduce a standardised instrument for the evaluation of LA tools: The Evaluation Framework for Learning Analytics (EFLA) to be found in Appendix B. The framework can be used to measure and compare the impact of LA on educational practices. In our study that is: to make teachers aware of students use and perception and stimulate towards alternative teaching behaviour, e.g. adapting and improving the LACs. EFLA for teachers consists of 8 items in 3 dimensions (Data (2 items), Awareness & Reflection (4 items), Impact (2 items)) which are rated on a scale from 1 (*strongly disagree*) to 10 (*strongly agree*). In a standardised procedure the EFLA-score is calculated (Scheffel et al., 2017).

1.2 Research questions

The aim of this study is to identify teachers' needs with regard to students' information, i.e., their interaction with online LACs, and to design a LAD for teachers to support improving those LACs. The overarching research question thus is: *What information do teachers want to know on students' use and perception of learning activities to improve those learning activities and how could this information be presented in a learning analytics dashboard?* We will answer the next sub-questions:

- RQ 1 Which online learning activities are currently being used in courses at Hogeschool Windesheim?
- RQ 2 What information do teachers need on how students *use* online learning activities in order to be able to improve those learning activities?
- RQ 3 What information do teachers need on how students *perceive* online learning activities to be able to improve those learning activities?
- RQ 4 How could such information on learning activities be visually presented in a learning analytics dashboard for teachers?
- RQ 5 How are developed dashboard prototypes evaluated by teachers with regard to aspects data, awareness, reflection and impact?

This research uses a mixed method design (Creswell, 2014). Next section first describes method, results, and discussion for collecting quantitative data using a survey (Appendix A). This is followed by chapter 3 on the construction of prototype 1 (P1). Chapter 4 describes method, results, and discussion for the collection of qualitative data using interviews. In chapter 5 the construction of prototype 2 (P2) is detailed, followed by method, results, and discussion on the P2-interviews in chapter 6. Finally, chapter 7 brings discussion and conclusions.

2. Survey

2.1 Method

Design. A cross-sectional survey (Fowler, 2013) was composed to collect quantitative data on LACs currently used and teachers' needs for information. Besides that, ideas on the design and use of dashboards are gathered.

Participants. Participants of this study are teachers of Hogeschool Windesheim (HW), a HEI in the Netherlands. The survey aimed specifically at those teachers who attend to the online LACs of the courses they teach. Most teachers teach full-time (FT) courses for young adults, some teach Lifelong Learning (LLL) courses for professionals; some teachers work both lines of education. At HW about 36% of the teachers is over 55 years of age and 9% of the teachers is younger than 35, according to the Personnel Department of HW (counted on 01/05/2020). All teachers have one or more master's degrees, some have a PhD, and all are specifically trained in assessments skills. Their expertise lies in "Content Knowledge" and "Pedagogical Knowledge". Just few of them are specifically trained in what Koehler and Mishra (2008) raise as "Technological knowledge". The survey was sent out to all 773 teachers of the Business Department and Education Department. A priori power calculation for χ^2 Goodness-of-fit test contingency tables showed a sample size of 145 to reach 0,95 power (Df=1, α = ,05 and effect size ω = 0,3).

Materials. Since no validated instruments were found that fit our study purpose, a survey was composed (Appendix A) using information from Bodily et al. (2018) and Lukarov, Verbert and Schroeder (2019). The survey starts out with two filter questions to make sure the respondent is a) a teacher and b) is (re)designer of online courses. Then most questions offer a list of pre-formulated alternatives in which more than one answer can be checked, alternatives can be added by typing in blanks. The survey consists of four groups of questions:

1) Q1 to Q3 are questions on characteristics of the courses: target group, used platform, list of pre-formulated LACs (three Content-LAC, three Communication-LAC and four Construction-LAC (Kerres and De Witt, 2003)).
2) Q4 to Q13 relate to each of the LACs ticked in Q3 (adaptive survey set-up) with a list of mainly action-related indicators (Schwendimann et al., 2017).
3) Q14 and Q15 are questions on how information is collected and presented.
4) Q16 to Q20 collect teacher characteristics: willingness to use a LAD, ideas on privacy, technological skills, age, and gender.

Procedure. The survey content was constructed, pilot-tested and prepared in an electronic web-based survey tool LimeSurvey. It starts out with a request for informed consent and takes approximately 8 minutes to complete. To realise distribution, permission was required from the Department of Quality, the Research department, and management of HW departments involved. After a delay of several weeks, a precise time slot was assigned, since many competing (Covid 19-related) studies, also aiming at teachers, were carried out at the same time. The survey link was distributed by mail in the first half of September 2020 during a time when teachers were in the middle of a work overload due to course conversions and working from home because of Covid 19. An additional online appeal to participate was posted on intranet twice. An individual reminder was sent out by mail after 10 days.

Analysis. Survey data was analysed using descriptive statistics to summarise the overall tendencies. Raw data contained 97 cases, in the process of preparing the data 20 cases were removed because of missing data. A demographic profile of respondents was drawn up and for RQ1 to RQ15 multiple response variable sets were defined and frequency tables produced. Contingency tables were created to look at differences between FT-courses and LLL-courses.

2.2 Results

The survey was sent to 773 teachers, 97 surveys were submitted, 77 of which were complete, i.e., a 10% response rate. Post hoc calculation for χ^2 Goodness-of-fit tests contingency tables showed a power of 0.75 (Df=1; $\alpha = .05$; $\omega = 0.3$). Most respondents reported to use basic LACs and have basic needs: how often students click on links to texts and videos, hand in assignments or attend to lectures. Even more respondents expressed needs to know how helpful students perceive LAC-items. Over 90% stated to use a LAD like this when available.

When looking at the demographics half of respondents is over 50 years of age: 40 % is in the age group 51-60 and 10% is older than 60. 29% is between 41 and 50 (29%) and 19% between 31 and 40 years of age. More women (60%) than man (40%) responded. On technological skills 59% of respondents value themselves as medium skilled, 38% as high skilled and just 3% of the respondents think of themselves being low technologically skilled.

Respondents were asked to choose one of their courses to apply the survey questions to. The chosen courses are aimed at either FT-students (83%) or LLL-students (26%) of which 9% aim at both target groups. When asked which platforms they use for their chosen course, most entered multiple answers: 87% of the participants report to use ELO, 77% uses Teams, 23% Rise Articulate and 5% Xerte. Other platforms mentioned are: Peergrade, Studiemeister and Zoom. We infer courses for FT-students working with ELO and Teams to be prevalently represented.

Online Learning Activities

Of the online learning activities (LAC) the teachers currently use, the four most mentioned LAC are: let students read texts (92%), have students attend online lectures (79%), let students watch YouTube videos (74%), and ask students to do formative assignments (70%). As shown in Table 2 FT- and LLL-courses use the same four LACs most. To establish possible associations between a LAC and either FT- or LLL-courses, Fishers' exact test was used since expected values were under five. Just one of the LACs shows a significant relation to either FT- or LLL-courses (χ^2 (1), $p < 0.05$). There is significant difference between the use of formative quiz when comparing FT-courses and non-FT courses: 39% of the FT-courses (N=64) used formative quiz compared to 8% of the non-FT courses (N=12). LACs suggested by respondents are slideshows with audio (mentioned twice) and podcasts, formative oral tests, video assessments, peer feedback and skills training with Traintool (all mentioned once).

Table 2

Use of Learning Activities in Full-Time (FT) and Lifelong Learning (LLL) Courses

	Total (n=76)		FT (n=64)		χ^2 (df=1)	LLL (n=19)		χ^2 (df=1)
Learning activities	#	%	#	%	P	#	%	P
Reading texts	71	**92%**	59	92%	1.000*	19	100%	1.000*
Videos on YouTube	57	**74%**	46	72%	.495*	17	90%	.246*
Embedded videos	40	52%	32	50%	.549*	12	63%	.445*
Open questions	17	22%	16	25%	.276*	3	16%	.535*
Formative quiz	26	34%	25	39%	.050*	3	16%	.054*
Flash card questions	8	10%	7	11%	1.000*	1	05%	.672*
Formative Assignments	54	**70%**	46	72%	.513*	14	74%	1.000*
Online lectures	61	**79%**	51	80%	1.000*	17	90%	.540*
Guided collaboration	45	58%	36	56%	.540*	12	63%	1.000*
Unguided collaboration	40	52%	32	50%	.549*	9	47%	.604*

Note. Frequency of learning activities used. Four most used learning activities are in boldface.
The total is less than FT + LLL, since some teachers serve both FT and LLL.
For Chi-square Fishers' exact test is used since several values are under five.
* $p < .05$.

Information needs

Looking at what information teachers need on student *use* and student *perception* of LAC to be able to improve learning activities, Table 3 shows respondents' needs on the four most used LACs (respondents reported on each of the LACs separately), a complete list of needs can be found in Appendix C.

When it comes to how students read texts, 72% of respondents for FT-courses and 68% for LLL-courses expressed a need to know how often students click on the link to the text and which links to texts are opened most (FT 68%; LLL 58%). 74% of respondents for FT-courses and 79% for LLL-courses wanted to know how helpful students perceive the reading texts. An indicator added by one respondent to the pre-formulated list is how much time students use to read a text.

About their students' use of videos respondents would like to know how often a link to open the video is used (FT 73%; LLL 65 %). FT 80% and LLL 71% wanted to know whether the video was perceived helpful by students. One respondent suggested an indicator which link is clicked on most.

With regard to how students use formative assignments FT 71% and LLL 79% of the participants would like to know how many assignments were submitted. How much time students worked on the assignment was most interesting for FT-respondents (FT 62%; LLL 50%). For FT as well as LLL 64% of the respondents wanted to know how helpful students perceive the assignments. One respondent adds an indicator that reports what causes an assignment to be less helpful.

For online lectures FT 79% and LLL 77% of the respondents would like to know the number of attendees per lecture. FT 83% and LLL 82% wanted to know how helpful students perceive each lecture and per series of lectures (FT 60%; LLL 71%). They also would like to know students' opinion on the pace (FT 71%; LLL 59%) and length of the lectures (FT 67%; LLL 71%). Added indicators are whether the students start related online assignments (one respondent) and how many and how often students interact with each other and the teacher during lectures (one respondent).

Further, we also asked whether respondents would like to be able to compare use and perception of learning activities between semesters: 79% wanted to be able to compare (n= 57). Respondents' remarks at this item show concerns that comparing semesters will be distorted when learning activities are altered.

Table 3

Teachers' Needs on Four Most Used Learning Activities

Learning activities	Teachers' needs on information	FT	LLL
Reading texts[a]	**Whether students click on the link to the text**	**72%**	**68%**
	How long before students click on other activity	42%	42%
	Which links to texts are opened most	**68%**	**58%**
	How helpful students perceive the reading texts	**74%**	**79%**
	Which links to texts are least opened	51%	37%
	Whether there is a technical problem with this item	33%	37%
Videos YouTube[b]	**Whether students click on the link to the video**	**73%**	**65%**
	How long before students click on other activity	43%	29%
	The amount of video links clicked on	52%	29%
	Which links to videos least clicked on	46%	41%
	How helpful students perceive the video	**80%**	**71%**
	Whether there is a technical problem with this item	32%	29%
Formative assignments[c]	**How many assignments were handed in**	**71%**	**79%**
	Time students reported spent on the assignment	**67%**	50%
	How helpful students perceive the assignment	**64%**	**64%**
	Whether there is a technical problem with this item	26%	21%
Online lectures[d]	**Per lecture the number of attendees (synchronous)**	**79%**	**77%**
	How many questions are asked live or later	29%	24%
	Per lecture students' opinion on pace	**71%**	**59%**
	Per lecture students' opinion on length	**67%**	**71%**
	How helpful students perceive the lecture	**83%**	**82%**
	Per series the number of attendees compared	56%	53%
	Per series minutes attending compared	42%	53%
	Per series which lectures helpful	**60%**	**71%**

Note. This table shows a summary of most frequently marked teachers' needs on information on the four most frequently marked learning activities. Most mentioned needs are in bold face.
FT = Full Time and LLL = Lifelong Learning.
[a]n FT=57; LLL=19. [b]n FT=44; LLL= 17. [c]n FT=42; LLL= 14. [d]n FT= 48; LLL=17.

Preferred method for feedback collection

Respondents preferred specific methods to collect the feedback from students, as shown in Table 4. On FT-courses most preferred method is that students could express their perception in free text, either per activity (61%) or per cluster of activities (48%). For LLL-courses respondents equally liked collection of feedback through free text (59%) and marks 1 to 10 (59%).

Table 4

Preferred Method of Collecting Feedback from Students

Collection methods	FT[a]	LLL[b]
Thumbs up, thumbs down	23%	12%
Smileys	34%	18%
Score 1 tot 10	46%	**59%**
Free text per activity	**61%**	**59%**
Free text per cluster of activities	**48%**	35%

Note. Teachers show a strong like for students to give feedback through a free text method.
FT = Full Time and LLL = Lifelong Learning.
n[a]=56. [b]n=17

Willingness to use LAD

On a question whether the respondents would use data from a LAD to improve learning activities when available, almost all respondents answered "yes" (FT 88%; LLL 90%). On FT-courses one respondent would not use a LAD arguing that speaking to students directly would be more valuable and would invite students to reflect on their role too. 10 % was not sure yet to use data from a LAD, arguing that it depends on content, usability, and doubts on benefits. Most respondents stressed their choice by expressing an urge to improve their learning activities and the importance of student feedback to understand what is helpful for them as shown in Table 5. An attempt was made to do a logistic binomial regression to determine the relationship between "Willingness to use LAD" and age, gender, and technological skills. This, however, did not work out since just one of the respondents was not willing to use the LAD.

Table 5

Response on the Question: "Would You Use Data from a LAD to Improve Your Learning Activities?"

	FT[a]	LLL[b]
Yes, I would use LAD	**88%**	**90%**
No, I would not use LAD	2%	0%
I do not know yet	10%	10%

Note. Teachers show a strong like for students to give feedback through a free text method.
FT = Full Time and LLL = Lifelong Learning.
n[a]=58. [b]n=19

Ideas on privacy

When asked about their ideas on privacy respondents were less unanimous and varied between FT and LLL. For FT-courses 59% think that using students' data is within the GPDR principle of data-

use as part of the contract between the student and HW to deliver good education and 41% find students should be asked formal consent per course. For LLL courses respondents think otherwise: the majority of respondents (63%) state that students are to be asked for their consent and 37% reckon it is within the contract to use data for improvement of learning activities as shown in Table 6. Noteworthy is that 21 respondents felt the urge to underpin their opinion: multiple times transparency and actively informing students on this use was mentioned and the importance of anonymity was stressed. Also, a concern was mentioned on how this information would be used by management.

Table 6

Response on the Question: "Do You Think You May Use Student Data that is Logged Unseen?"

	FT[a]	LLL[b]
Yes, this is within grounds GPDR	**59%**	37%
No, students must give consent	41%	**63%**
No, not at all	0%	0%

Note. Teachers show a strong like for students to give feedback through a free text method.
FT = Full Time and LLL = Lifelong Learning.
[a]n=58. [b]n=19

Looking for relations between independent variables age, gender, or technological skills and dependent variable ideas on privacy a logistic binominal regression was done. No significant outcomes were found as shown in Table 7.

Table 7

Logistic Regression Analysis Technological Knowledge, Age and Gender by Ideas on Privacy.

Independent	B	S. E	Wald	df	Sig.[a]	Exp(B)
Step 0 Constant	-.421	.281	2.250	1	.134	.656
Tech. Knowledge	-.169	.522	.105	1	.746	.844
Age	-.065	.288	.051	1	.822	.937
Gender	.132	.584	.051	1	.821	1.141
Constant	.011	1.715	.000	1	.995	1.011
Test			Chi^2	df	Sig.	
Omnibus			.173	3	.982	
Hosmer en Lemeshow			13.042	8	.110	

Note. -2 Log likelihood = 71,001. Cox and Snell R^2 = ,003. Nagelkerke R^2 = .004.
FT = Full Time and LLL = Lifelong Learning.
[a]p < ,05.

2.3 Discussion

To answer RQ1 (Which online learning activities currently are being used in courses at HW), we identified the most frequently used learning activities: letting students read texts, attend online lectures, watch YouTube videos and do formative assignments. Noteworthy is that all four LACs are used by more than 70% of respondents; moreover, in LLL three of these LACs are used by over 90% of respondents. Looking at the 3 C-model for classification (Kerres & De Witt, 2003) respondents claim to need information on Content learning activities as well as Construction learning activities.

For RQ2 (What information do teachers need (in order to be able to improve learning activities) on how students *use* online learning activities) we summarize indicators on the four most used LACs. On reading texts most respondents expressed a need to know whether students do click on each of the links to the reading texts. About videos respondents also want information on whether students click on the links. For online lectures respondents want information on the number of attendees and finally on formative assignments respondents mainly want to know whether these are submitted. All these needs were reported by approximately 60% or more respondents. So, to put it short as for students' *use* most teachers want to know whether the activities were done.

For RQ3 (What information do teachers need on how students *perceive* online learning activities (in order to be able to improve those learning activities)), on all LACs most respondents reported they want information on how helpful students *perceive* the item. Besides that, respondents also would like to know students' opinions on pace and duration of lectures and FT-students' reports on time spent on an assignment. Looking closely at the percentages on teachers' needs we take note that for three out of four learning activities more respondents would like to know about students' perceptions than about usage information, even though the percentages are not far apart. This is interesting since usage information is implicitly retrieved information, automatically logged and available, while students' perception is explicitly retrieved information. Moreover, teachers want this information most preferably in free text (FT and LLL) or scores 1 to 10 (LLL), this requires advanced feedback systems and students' cooperation to provide input. It can be automated but could distract the student form learning (Dooms et al., 2011).

Interesting information, even though not within the research questions, are the opinions on the privacy aspect and the use of a LAD. Concerning requiring a consent per course for the use of data, respondents show a 40-60% ratio depending on courses for FT (more no) or LLL (more yes) students. On the use of a LAD the majority of respondents (over 90%) would like to use data from a LAD to improve LACs.

This part of the study has obvious limitations that need to be addressed: The response on this survey is small, just a 10%. It has not enough power to draw conclusions. So, none of the above can be generalized to the population of the teachers of the two departments of HW. Besides that, there might

be bias in the results too, which threatens internal validity. Firstly, working with data does demand specific skills and an open attitude, even though all teaching staff owns a master's degree, being interested in data processing is not self-evident and almost all respondents claim to have mediate- to high technological skills, which probably is not representative for all staff. Secondly this study was conducted amidst a period of societal unrest because of Covid 19. Teachers were forced to shift to home-working and provide almost all classes online. This situation might have influenced the response and might also have strengthened extremes in attitudes towards the use of digital means in education. It is quite plausible that many teachers were not drawn to the subject of this survey and chances are that this survey might have been predominantly completed by a group of teachers who already had an affinity with the subject.

In all, even though the results are not generalisable, it is plausible that with a larger response the same the LACs and the needs would have been found, so they were used to create a LAD-prototype.

3. Design Prototype 1

The purpose of the LAD is to inform teachers on how students use and perceive LACs to enable them to decide on improvements in learning activities. From the survey outcomes the top four LACs were selected with their top four indicators. A set of student data has been manually fabricated: a course called "Research Skills, an Introduction" was constructed, containing 6 reading texts, 5 videos, 4 formative assignments and 8 online lectures for a group of 36 students of whom 30 consented to using their data. Usage data and student remarks and reviews were carefully constructed to mirror a real course, these can be found in Appendix D. Next, with this dataset in mind, a wireframe was designed to draw-up a first lay-out sketch with general information and the information per LAC. Then in an iterative process, suitable visualisations were sought using Few's guidelines (2013). A simple bar chart was chosen for quantitative information to enhance fast comprehension. Finally, a mock-up dashboard was produced in Power Bi. In Figure 4 a model of the LAD is shown.

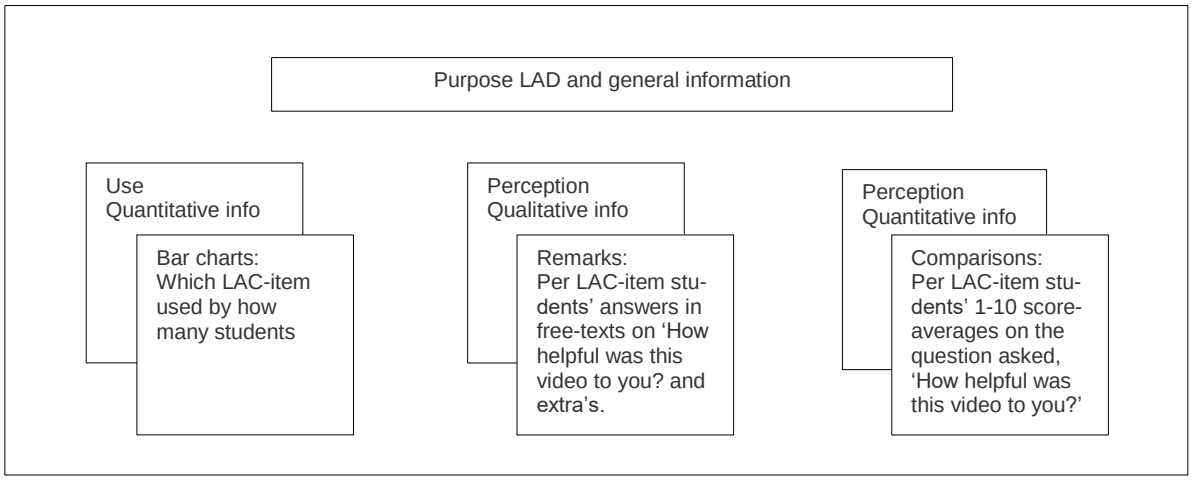

Figure 4. Model for LAD-design for improvement of LACs based on teachers' needs.

Screenshots of Prototype 1 (P1) are shown in Figure 5 and 6. The header contains the content of dashboard, dates of data collection, course title and the number of students offering data from the total number participating in the course. Then in each of the four segments data on a LAC: reading, videos, assignments, and lectures. On the main dashboard quantitative data is presented in bar charts: which links to reading text and video are clicked on by how many students; which assignments are submitted by how many students and what number of students is present on each of the lectures. When holding the pointer (hoovering) on one of the bars, qualitative data pops up: a set of short student remarks are offered on each of 6 reading texts, 5 videos, 4 assignments and 8 lectures (as of now called LAC-items). These remarks are collected by asking students: "How helpful is this text/video/assignment/lecture to you?". On assignments an additional question is asked: "What amount of time did you spent on

this assignment?" On lectures students are additionally asked for their opinions on the pace and duration of the lecture, this data is also reported in the pop-ups. Finally, four comparison buttons can be clicked to open more quantitative data on each of the LAC-items: In the first comparison each of the 6 texts (with title) is listed with an average score of students' reviews next to it; under the second comparison button each of the 5 videos (with title) is listed with the average score of students' reviews and so on. Worth mentioning is that two groups of students are not represented in the data: per LAC-item students who did not click/hand in/attended and students who did not consent to using their data.

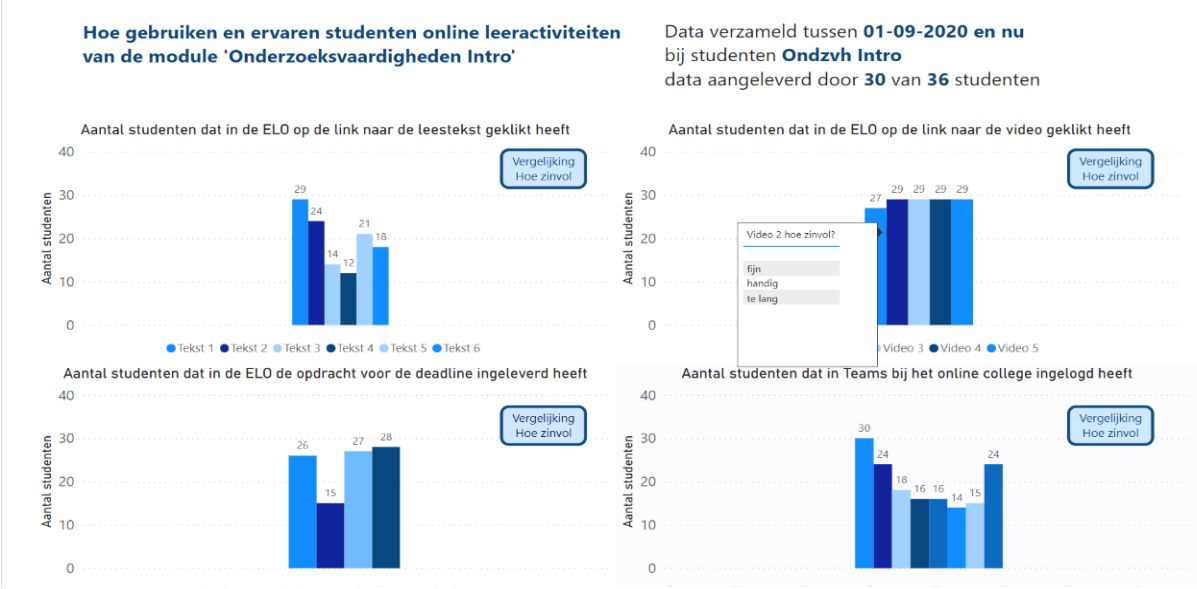

Figure 5. A screenshot from P1 constructed in Power BI, a mock-up dashboard for teachers to be used for improving learning activities. Information is given on four learning activities. Besides the information in the bar charts, hoovering on each of the bars will uncover a pop up with qualitative information (feedback remarks from students on each item). Clicking on the comparison-buttons will uncover more qualitive information on student perception per learning activity.

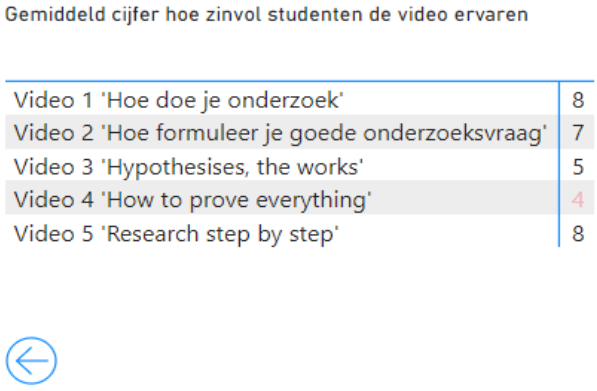

Figure 6. A screenshot with information that can be retrieved when clicking on the comparison-button. Here the average score from students' ratings on the question "How helpful is this video to you?

4. Interviews Prototype 1

4.1 Method

Research design. To test and evaluate LAD-design we collected qualitative data through observation and interviewing combined. We used a think aloud protocol (Observational study, Wilson, 1994), the EFLA (Scheffel et al., 2017) and semi-structured questions.

Participants. In the context of Covid 19 and related teachers' high workloads participants were recruited at the end of the survey by a call to contribute to a follow-up. A selection of 5 teachers was made from 18 volunteers solely on ground of short-term availability. The interviews were done with 3 women and 2 men. Two participants were over 50 years and three between 40 and 50 years of age. Three scored themselves as highly - and two as mediate technologically skilled. Three of them teach only FT-students and two both FT and LLL-students.

Materials. Besides LAD-P1 an interview protocol was used consisting of four parts: An introduction, the observation, the teacher EFLA (Scheffel, 2017) (to be found in Appendix B) and semi-structured questions consisting of following open questions:

- *Which part of the dashboard is most interesting to you?*
- *Which part is hard to understand?*
- *What information is missing?*
- *What information could be eliminated?*
- *Looking at the data, what actions would you take to improve your learning activities?*
- *Do you have any other questions?*
- *Would you use this LAD when it was available to you in the ELO?*

Procedure. The interviews were conducted in October 2020. Each of the selected participants was personally invited by mail to an individual session and was asked to return a signed Informed Consent. All interviews were done online using a video-communication tool called Teams (Microsoft). At the start of the interview the aim of the study was reiterated, then participants received introductory information on the function of the LAD and the interview. Next P1 in Power BI was shared on screen so participants could see the prototype on their own device and video recording was started. After a short instruction, "screen control" was handed over to the participants, so they could autonomously explore the LAD. Both participants' pointer movements and verbal texts were video recorded. Each participant was initially given a maximum of 5 minutes to explore the prototype which he/she could extend. In one interview a participant experienced a dysfunctional pointer control, which was solved by the interviewer controlling the pointer on command of the participant. Another interview had a short technological delay. The interviewer observed, took notes, and encouraged participants to express their thoughts, questions, and remarks. The interviewer was alert not to explain any of the visualisations during this part of the interview but did give instructions when interviewees were at risk of missing parts of the dashboard. After observation, the interviewer explained the score-procedure for the EFLA for teachers (Scheffel et

al., 2017), read the eight questions one by one and wrote down the scores. Finally, the participants answered a set of semi-structured questions as described in the interview-protocol ending with the option for the participant to add comments. All interviews P1 took less than half an hour.

Analysis. The interview recordings were transcribed and thematic coding (Evers, 2015) was used for descriptive analyses. Interviews on P1 offered a plethora of information: All information was coded in 6 codes: (a) valuable, (b) not valuable, (c) help researcher, (d) actions, (e) suggestions, and (f) questions and remarks. Code "valuable" was subdivided into valuable on quantitative data, - qualitative data, and on total LAD. Code "not valuable" was not split up since little remarks were made. Code "actions" records actions on LAC improvement mentioned by interviewees. Code "suggestions" was split into suggestions for technological improvements and suggestions for extension of the dashboard with in-depth information. Code "help researcher" was used to collect moments interviewees did not discover LAD features by themselves and the researcher provided them with clues. Finally, code "questions and remarks" was used to categorise questions and remarks that were interesting for the context of the LAD, but not directly related to the aim of this research.

4.2 Results

Most interviewees showed enthusiasm on P1, many suggestions were done, mainly for adding effectivity measures, time measures and more clarity on origin of data. When we look at the quantitative information found valuable: 5 out of 5 interviewees were interested in how many students opened the reading links and the video links, which assignments were submitted or how many students were present at lectures. Most positive comments were made on the first two. Opening the comparison buttons 4 out of 5 showed enthusiasm on the reviews in figures on the question how helpful students valued each LAC. Qualitative information was found valuable too: 4 out of 5 interviewees expressed a surprised and positive response on the fact that students' opinions in free text were available on each of the items. The total LAD was valued by 4 out of 5 interviewees, they would absolutely use the dashboard; one interviewee indicated he could not use the dashboard, since his learning design is unfit, currently his students read from books and the transfer of knowledge occurs mostly in class where he can witness whether students comprehend or not. The LAD would give him a drive to flip his course design, this dashboard would close the feedback loop he needs to switch to more coaching in class.

All 5 interviewees recognised some "not valuable" parts of the dashboard. One interviewee would not use the dashboard until it is enriched with information on effectivity. Another two interviewees also realised the LAD misses effectivity measures. Besides that, the risk of acting on remarks or rates of just a small part of the students was pointed out. Three times an interviewee was trying to value students' reviews or remarks: "Are these students who read the text?"; "Are these students the same as

these 12 students here?" The origin of the free texts remarks and reviews was not clear to interviewees. Other comments were on details on assignments and lectures, all of which were reported as suggestions.

In 4 out of 5 interviews the researcher had to assist on holding the pointer on a bar to uncover qualitative information, the students' remarks on items. So these were not found automatically. In 2 out of 5 interviews help was needed to click on the comparison buttons. All interviewees were able to state actions they would take on improving LACs: 4 did so on all: reading, videos, assignments, and lectures. One focussed on lectures only. Several mentioned a first step to start conversations with students to find out more information.

These are suggestions made by more than one interviewee for in-depth information as well as technological information:

- Add test results and connect these to student behaviour and remarks (3x)
- Add information on how much time students spent on videos (2x)
- Add information on how much time students spent on reading (2x)
- Add a question: "Would you recommend this item to other students?" (2x)
  Add a question: "Do students enjoy this item?" (2x)
- Qualitative information: Cite asked question to each box of free remarks, add number of students that made remark, explain origin of free text answers: who is asked when what questions? (3x)
- Quantitative information: Clarify text on comparison button. (2x)
- Quantitative information: Add number of students that the average is based on. (2x)
- Quantitative information: Use percentages in comparison. (2x)
- Total LAD: Use more colour variation (2x)

A complete summary of in depth and technological suggestions is found in appendix E. Also questions and remarks interviewees made during the interviews are found in an appendix F. The scores on the EFLA-questionnaire will be reported together with those on P2 in section 6.2.

4.3 Discussion

To answer RQ4 (How could information on learning activities be visually presented in a learning analytics dashboard for teachers?) we may conclude that P1 was welcomed within the first 5 minutes and most interviewees expressed enthusiastic reactions mainly on students remarks in free texts. Nevertheless, some important issues were raised: measures on effectivity with links to student behaviour and remarks are missed as or time-measures on texts and videos. Besides that, on quite a few aspects clarification is necessary, i.e. P1 is not suitable yet to present information to teachers.

To put results of these interviews in perspective some limitations must be mentioned: Five interviewees to test a LAD is a small number to retrieve information even though Research-Based User Experience (Nielsen/Norman Group, 1998) claims this number is sufficient to reveal almost as many usability problems as one would find, using many more test participants. Besides the small numbers, selected interviewees might not represent teachers of the two departments of HW correctly, being mediate- and high technologically skilled and selected from a group of people who showed specific interest in research on data use in education. This method of selecting interviewees narrowed down the chance to invite interviewees with a negative attitude towards working with a dashboard or who would have problems understanding it.

5. Design Prototype 2

Suggestions from interviewees on P1 outnumbered feasible changes, so choices had to be made. Besides that, a number of suggestions could not be included in the new prototype because of technological challenges or due to limited time. Since interviewees were mainly enthusiastic about P1 most features were kept. Alterations were made on in-depth information and technological presentation.

In-depth:

- Test results were added with a filter so one could either choose all information or "pass" - or "fail"-information and see related activities and remarks at a glance.
- The length of the video and the number of minutes the video was watched, was added.
- In the comparisons an additional question was added to reading texts and videos: "Would you recommend this to your fellow students?".
- Last semesters' course running was added to enable comparison between semesters using a filter.

Technological:

- On the qualitative information in each box the feedback-question that students answered was cited.
- On the qualitative information in each box the number of students who made a remark was added.
- A "Help-button" with an explanation page was added.
- The text on the comparison button was changed to "Click here for comparison".
- In the comparisons the number of reviews on which the average was calculated was added.
- More colour variation was added.
- Title of each of the LAC items received a link to the actual PDF, video, or presentation.
- The purpose of the dashboard was added to the title in the heading.
- A button with background information was added.

In Figure 7 the model is shown; in Figure 8 a screenshot from P2. In Figure 9 a screenshot from the information from one of the comparison buttons is shown.

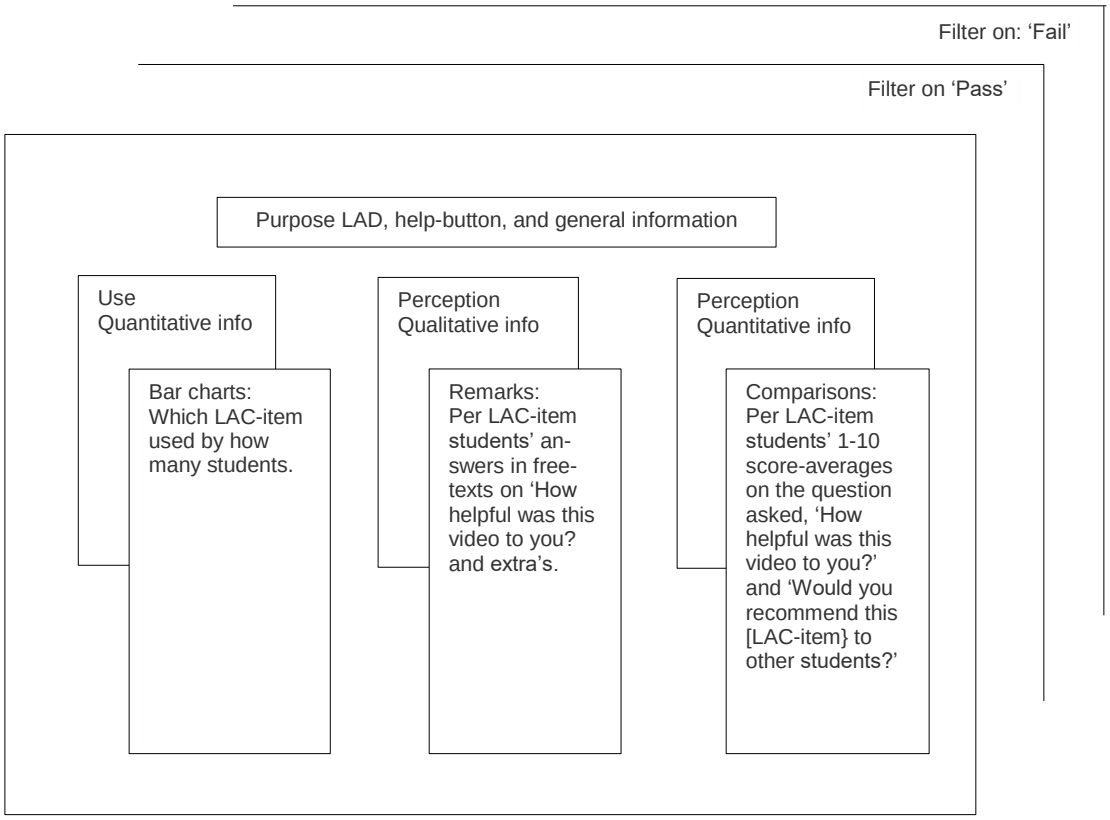

Figure 7. Model LAD-design P2: Comparing to P1 test-results are added by using a filter through which information from either "Pass" or "Fail"- students can be seen. Not in this model is the filter on last semesters' information.

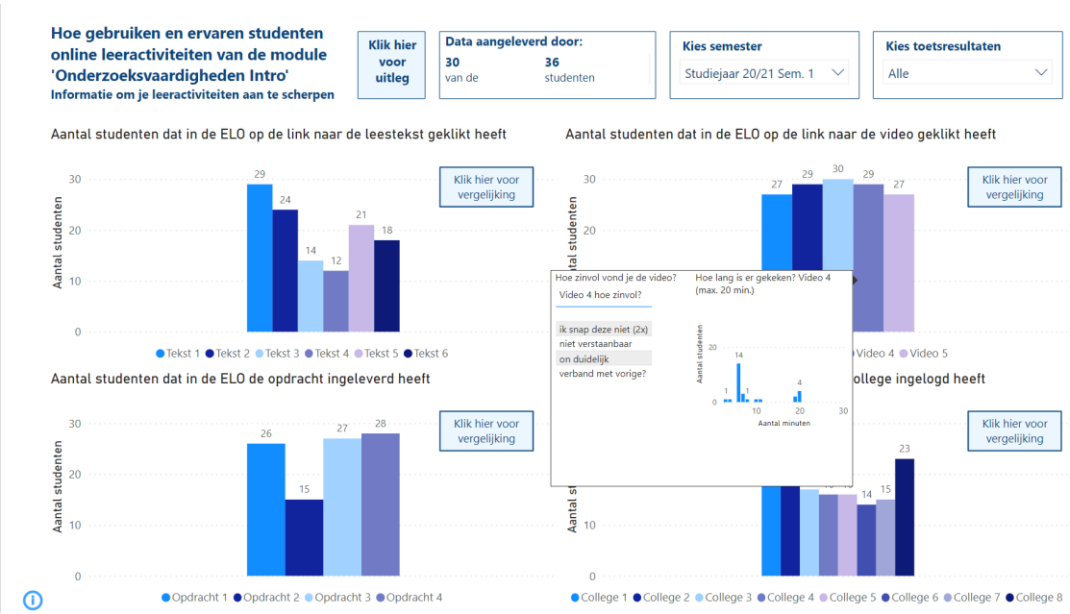

Figure 8. A screenshot from P2, a mock-up dashboard for teachers to be used for improving learning activities. In this version a number of changes are made. Test-results and data from last semester are added, more clarification is provided, and the time students watch videos is available.

Helaas is het nog niet mogelijk deze reviews uit te splitsen op voldoende of onvoldoende.

'Hoe zinvol vond je deze video? Geef een cijfer tussen 1 en 10' (Onderstaand cijfer is het gemiddelde.)
Studiejaar 20/21 semester 1 en Studiejaar 19/20 semester 2

Titels video's	Hoe zinvol 20/21 (v)	Hoe zinvol 19/20 (v)
Video 1 'Hoe doe je onderzoek'	8 (7 reviews)	7 (5 reviews)
Video 2 'Hoe formuleer je goede onderzoeksvraag'	7 (5 reviews)	7 (4 reviews)
Video 3 'Hypothesises, the works'	5 (14 reviews)	6 (11 reviews)
Video 4 'How to prove everything'	4 (15 reviews)	3 (12 reviews)
Video 5 'Research step by step'	8 (12 reviews)	7 (13 reviews)

'Zou je deze video aan een medestudent aanbevelen?'

Titels video's	Aanbevelen? 20/21 (v)	Aanbevelen? 19/20 (v)
Video 1 'Hoe doe je onderzoek'	11x ja/ 1x nee	6x ja/1x nee
Video 2 'Hoe formuleer je goede onderzoeksvraag'	9x ja/ 1x nee	6x ja/1x nee
Video 3 'Hypothesises, the works'	1x ja/ 6x nee	2x ja/5x nee
Video 4 'How to prove everything'	0x ja/14x nee	0x ja/7x nee
Video 5 'Research step by step'	12x ja/ 1x nee	7x ja/1x nee

Klik op de onderstreepte titels om je video te bekijken.

Terug

Figure 9. A screenshot with information that can be retrieved when clicking on the comparison-button. In P2 data on the question "Would you recommend this video?" was added.

As stated, not all suggestions were integrated in P2: To limit the number of questions students would have to answer, some of suggested questions were not added like whether students enjoy the LAC-item and how long it takes them to read texts. Due to technological challenges a tooltip on "Hold your pointer on a bar for remarks students" was not included and finally we chose not to recalculate to percentages in the comparisons, since this is rather questionable because of small amount of student-reviews.

6. Interviews Prototype 2

6.1 Method

For the interviews on P2 the same method was used as for P1. Five new teachers were selected from the same list of 18 volunteers, again with no other criterion than short-term availability. Interviewees were 4 women and 1 man, 2 were between 30 and 40 and the other 3 over 50 years of age. All 5 interviewees predominantly work with FT-students. 3 call themselves mediate- and 2 highly technological skilled.

The same protocol and procedure were followed as for P1, with one difference: The first interview on P2 was within half an hour as with P1, but the 4 following interviewees really needed more time to comprehend all aspects of the dashboard, some needed over 10 minutes. In one interview a technical problem arose, the interviewee was not able to control the dashboard herself, which was solved within the interview. After recordings were transcribed, analysis of the interviews was done with the known set of codes: a) valuable, b) not valuable, c) help researcher, d) actions, e) suggestions, and (f) questions and remarks. In conclusion the EFLA results were calculated following the related procedure: Dimensional scores are calculated via the averages per item and averages per dimension by rounding the results using a formula ((x-1)/9) *100), the overall EFLA-score is the average of the three dimensional scores. The score of P2 is compared to P1.

6.2 Results

P2 gained enthusiastic reactions too. Again, many suggestions were done, a first key one being cross-connections between students remarks and reviews with efforts and test results. A second suggestion was on finding another technique to present test results. First, we look at which quantitative information was found valuable: 5/5 interviewees liked the information on how often reading texts and video links were opened, assignments submitted, and lectures attended. Most attention was given to the reading texts and the videos, as one interviewee stated: "to do that, students need initiative, the other two are planned by us". All interviewees also liked the comparisons with the scores on the added "Would you recommend this"-question, even though the comparisons were harder to grasp since they contained more information. Valued in qualitative information: 5/5 appreciated this information, specifically mentioned were how many minutes students watched a video, how much time students reported to have spent on assignments and students' opinion on pace of lectures. One interviewee specified he finds the information very useful to help check whether the activities have the right quality. The complete LAD was also appreciated by all interviewees. All interviewees stated they would certainly use the LAD, arguing this information is currently being missed. One called the dashboard "a very useful tool, very action-oriented".

"Not valuable"-remarks were made too: The bar chart on attendees of the lectures was not valued by one of the interviewees who stated that students might be logged on to the course, but actually doing something else. Another statement was made that for reading texts it is not always relevant whether students find these helpful or not, they just must acquire contents. Parts of the LAD a teacher does not use for his course, invoked the idea to let teachers modify the dashboard themselves.

As for the researcher's help, two times explanations were necessary to hold the pointer on a bar to uncover qualitative information. Noteworthy is that just one interviewee opened the help page, another one needed help to open it to find the information sought for. Remarkably, all interviewees had to be alerted to use test-results. Once attention was drawn to this feature interviewees showed enthusiasm, but it was clear the information needed more time to process; conclusions drawn were not automatically correct ones. Interviewees kept clicking back and forward between the filters to try and connect information. Also, all interviewees had to be helped to find the feature to compare semesters, reactions were neutral to positive.

Just as for P1, all interviewees on P2 were able to state actions they would take on improving their LACs if this LAD was on their course. Three interviewees did so on all four LACs. Noteworthy is that some interviewees drew incorrect conclusions, e.g. on videos it was said "all is well" based on most students watching these, while the interviewee missed remarks and reviews on bad quality. Again, several interviewees mentioned as a first step to start conversations with students to find out more information.

Many suggestions were done during the interviews, this time a few for in-depth information and most on technological improvements. Most in-depth comments were done by just one of the interviewees, but a few stand out, either it was mentioned more than once or had already been mentioned in the previous interviews:

- Cross-connect (anonymous) per student on study actions, remarks, scores, and test results (3x)
- Add information on how much time students actually spent on reading. (2x)
- Add self-judgement questions on "Do I grasp this topic"; "Does this LAC make me better professional". (2x)

Technological suggestions were drawn from comments and observations that interviewees came to false conclusions or took unintended routes on the dashboard:

- Show test results differently e.g. "pass" and "fail" in green and red in the bars and in remarks; keep the choice for a neutral display. (2x)
- Relate number of the students that provided qualitative information (remarks) to number that uses LAC. (2x)
- Clarify quantitative information in comparisons and use percentages. (1x)
- Indicate that hoovering on a bar shows qualitative information. (2x)

A complete summary of in-depth - and technological suggestions is found in appendix E.

Finally, we look at the EFLA-scores: the prototypes were evaluated regarding the aspects Data, Awareness and Reflection, and Impact. The scores are shown in Table 8. On P1 the overall EFLA-score was 66.3, on P2 the overall EFLA-score was 74.1. The increase of 7.9 points can be ascribed predominantly to Awareness and Reflection, and Impact equally. The average scores of 9.2 on "The dashboard makes me aware" and "The dashboard stimulates me to adapt my learning activities" is worth highlighting.

Table 8

Scores on the EFLA (Scheffel et al., 2017) for P1 and P2 of a Mock-up Dashboard for Teachers to be Used for Improving Learning Activities

Evaluation Framework Learning Analytics

		Interviews P1						**Interviews P2**					
		1	**2**	**3**	**4**	**5**	**Average**	**1**	**2**	**3**	**4**	**5**	**Average**
Data	For this LA tool it is clear what data is being collected.	10	5	8	8	8	**7.8**	7	8	7	9	8	**7.8**
	For this LA tool it is clear why the data is being collected.	7	2	4	8	7	**5.6**	8	10	4	3	5	**6.0**
							6.7						**6.9**
Awareness & Reflection	This LA tool makes me aware of my students' use and perception of the learning activities	6	8	6	9	9	**7.6**	8	10	9	9	10	**9.2**
	This LA tool makes me forecast my students' possible future use and perception of the learning activities given their (un)changed behaviour.	7	6	4	9	9	**7.0**	6	10	4	6	6	**6.4**
	This LA tool stimulates me to reflect on my learning activities	9	8	4	9	10	**8.0**	9	8.5	8	10	9	**8.9**
	This LA tool stimulates me to adapt my learning activities if necessary	8	7	4	9	9	**7.4**	9	10	8	10	9	**9.2**
							7.5						**8.4**
Impact	This LA tool stimulates me to make the learning activities more efficient	7	8	4	8	8	**7.0**	6.5	4	8	8	8	**6.9**
	This LA tool stimulates me to make the learning activities more effective	7	7	4	5	9	**6.4**	6.5	10	8	9	9	**8.5**
							6.7						**7.7**
					((x-1)/9) *100)		**66.3**						**74.1**

Note. Scores of P1 and P2 on Evaluation Framework for Learning Analytics (Scheffel et al. 2017). Dimensional scores are calculated via the averages per item and averages per dimension using a formula ((x-1)/9) *100) to round the results. Comparing results of P2 to those of P1 brings an increase of 7.9 points.

6.3 Discussion

When we previously looked at how the information could be visually presented (RQ4) we concluded some important issues needed to be resolved: measures on effectivity with links to behaviour and remarks, time measures on texts and videos and more clarification on how data is collected. Looking at the results of P2 we can state that interviewees were enthusiastic about the LAD, however, these three aspects of the dashboard were just partly solved and would need work in a next version. Firstly, on effectivity measures: Besides the fact that none of the interviewees looked for test results by themselves, the filter-technique chosen did not work efficiently. Interviewees wanted to link other information than was anticipated; to find sought after information they had to switch between filters. A wish was expressed to be able to see "Pass" (green) and "Fail" (red) in one bar with related remarks in the same colour. After the quest on test-results, none of the interviewees paid much attention to the feature to compare semesters, similar problems might arise here. We can conclude that "information at a glance" (Few, 2013) in interactive tools needs more preparation with user-studies just as Nielsen/Norman Group (1998) state. Secondly, time measures on videos were integrated and appreciated, on reading texts no time measurement is available yet, this needs further attention. Lastly, more clarification on the origin of data was provided in P2, this worked well, but did uncover new demands. Interviewees found that it was hard to value remarks and reviews if they were not related to behaviour and test-results, so more cross-connection is needed at student-level. This wish for cross-connection of data is justified since a score from a student who invested time differs from the same score from a student who did not try. So, teachers need information on how to value a score. However, cross-connection would make it possible to track one student at the time, which could endanger anonymity in smaller groups. Apart from the privacy issues, this is where in practice the purpose and the use of the LAD might get mixed up. Instead of focussing on improving their own design of learning activities, teachers may start to draw conclusions on individual students and take corresponding actions based on (incomplete) information on learning efforts. Archer & Prinsloo (2019) for one warn that default positions of LA may impact negatively on students realising their potential. Careful consideration is key here, until more is known on the effects of teacher behaviour towards students based on 'incomplete by default' LA.

Finally, to answer RQ5 (How are developed dashboard prototypes evaluated by teachers with regard to aspects data, awareness & reflection, and impact?) we look at EFLA-scores: the lowest score - constant in both prototypes- is on the Data-item "It is clear why the data is being collected" and even though the purpose of the dashboard was literally stated in the heading of the P2 "Information to improve your learning activities" the score on this EFLA-item did not rise much. This accentuates the necessity to place this information more prominent. On aspects of Awareness & Reflection P2 scores very well (approximately a 9), except for "makes me forecast", which was somewhat downplayed by interviewees with "In education things change continuously, so nothing is predictable". The high scores seem to

reflect enthusiasm of the participants. Lastly, concerning the items on Impact it is noteworthy that interviewees used a variation in definitions of 'efficiency' and 'effectivity' and some did admit to not differentiate between the two constructs. The scores on those two questions might therefore be off. The questions did trigger in several interviews that test results would be useful, so here the research instrument influenced perception of the dashboard, which was on the other hand helpful for the cause of improving the dashboard. Again, results of these interviews might be biased for reasons stated before, validity of the EFLA-figures might be extra vulnerable due to the small number of interviewees and the extremes in scores. Even more important however, the method of evaluation of the dashboard was limited. We confined ourselves to what Jivet et al. (2018) state as the primary focus on evaluation of dashboards: "whether its goals are fulfilled". We did not evaluate impact on affect and motivation as recommended. We did not use validated usability -, usefulness - or user satisfaction tests, nor did we use real data in real educational situation for this dashboard (Schwendimann et al., 2017). We did look at intended actions, but not at real actions being taken (Jivet et al., 2017). So, an ideal evaluation would in a real situation measure real impact on improvements in learning activities and should also assess whether teachers understand, agree, and interpret data well (Jivet et al., 2018). We may conclude that the latter would have been a welcome addition to the evaluation of our simulation, because of some misinterpretations. Greller & Drachsler (2012) already mentioned this internal limitation for the implementation of LA: using a dashboard requires new higher order competences to enable fruitful exploitation. A specific warning is in place since student feedback in class is merely a matter of impressions (gut-feeling) and this data comes "in print" in exact figures. How teachers interpret feedback "in print" is a matter that needs further research. Our interviews showed that conclusions were swiftly drawn and more than once flawed. Development of "data literacy" is essential, state Ifenthaler, Gibson, Prasse, Shimada and Yamada (2020).

7. Discussion and Conclusion

Concerning our first research question which LACs are used most, we found that most respondents selected reading texts, YouTube videos, formative assignments, and online lectures. All four of them being quite basic learning activities. Previous studies enlist many LACs, e.g., Mishra & Koehler (2006) describe 42 different ones. Our survey was limited to ten LACs, some of those are bound to certain platforms; since the use of platforms turned out to be askew in this study (ELO is used most), this might distort outcomes.

When asked what information was needed on *use* of learning activities (RQ2) we reported about the most selected information needs on the four most used LACs: On each of the reading texts and videos most respondents want to know whether students do click on the links, on formative assignments whether these are submitted and for online lectures how many students attended each of them. Information on the first two appears to be most valued and requests were made by interviewees for amount of time spent on these activities. The choice for indicators on needs was basic too, partly this might be due to the limited number of indicators preformulated in the survey due to the limitation of the survey length. Lukarov et al. (2019) lists more than 280 different indicators, most aiming at influencing student-behaviour. Chances are other indicators are more needed than now have been identified in our survey.

When asked about student perception (RQ3) 70% to 80% of respondents selected how helpful students *perceive* items on reading, videos, and lectures. Additionally, they would like to know students' opinions on pace and duration of the lectures and self-reports on time spent on assignments; interviewees later mentioned a need for reports on the amount of time spent on reading texts. Noteworthy is that more respondents selected perception-indicators than usage-indicators. Surprising outcomes since in literature little was found on perception-data in dashboards, none of Lukarovs' indicators (2019) report perception. Either explicit information is not part of the field of LA or non-found key words are in use. One wonders, since nowadays the world of Netflix, YouTube and Tik-Tok is run on users' feedback.

The fourth research question is answered by presenting a dashboard design that was welcomed by interviewees who raised important issues on effectivity- and time measures, clarity in origin of data and cross-connections between data to be able to value remarks and reviews. For the first issue, proper techniques will have to be found to show information "at a glance" as might be the case for comparisons between semesters. Clarity on the origin of data will partially solve itself when instruments for collection of this data are in place in the systems, but still needs attention within the LAD to guide proper interpretation. With respect to the cross-connection of data further research is needed to find out how to secure the use of the data to its' purposes.

Concerning the evaluation of the LAD by teachers (RQ5) we can conclude the LAD clearly passed the test and at the same time there is room for improvement. For further development of the LAD

a more comprehensive evaluation approach is strongly recommended.

For future studies on the subject of using student data for improvement of learning activities, several lines could be followed: A first line is whether student perception is part of - or can be integrated in LA. A second line could explore how teachers' interpretations of student perceptions in a dashboard differ from student perceptions in face-to-face situations. A third line of research could be about how data can be displayed cross-connected in such a way that users stay focussed on the evaluation of their learning activities. Finally, the privacy issue will be defining the trustworthiness of students' data or their willingness to consent to their use of data (Ifenthaler & Schumacher, 2016). So, research to find out about students' opinions will be worthwhile, too.

Lastly we state a set of recommendations for HW to take a next step in using students' data:

- Involve teachers and students in privacy policies to create a tool that gains support.
- Explore available informed consent systems.
- Involve teachers in the design and evaluation of dashboards, noteworthy is that on a response of 77 teachers, no less than 18 teachers offered their time to think about data use in their work.
- Explore available feedback systems that will integrate with the ELO.
- Prepare (Corporate Academy) to teach all staff data interpretation skills.
- Prepare policies on what data is (not) allowed in Personal Evaluation Cycles.

In conclusion Viberg et al. (2018) stated that few have actually asked the question what kind of data would be valuable to analyse. Schwendimann et al. (2017) stressed the importance of studying particular requirements for different user groups. This thesis contributes by emphasising teachers' perspective. It shows the -not generalisable- results of a mixed method research looking into teachers' needs for students' usage and perception information to be able to improve learning activities and presents needed information in a learning analytics dashboard. Our main findings show that teachers would like information on very basic content - and construction learning activities (Kerres & De Witt, 2003) and action- and result-related indicators (Schwendimann et al., 2017) that show how many activities are done, how much time students spent on them and what results were. A remarkable outcome is that teachers do need information on students' perceptions at least as much as usage information. The prototype dashboard presented was welcomed enthusiastically, but to value information on behaviour, remarks, and reviews properly, test results and reciprocal links between all information appear to be conditional.

This study is limited by a small response on the survey (n=77), a limited amount of interviews (n=10) and some bias caused by ICT-skilled and data-interested participants and probably the context of Covid 19. Nevertheless, results can be used to draw attention to perception information as part of dashboard design for teachers. The proposed dashboard design along with teachers' responses can inspire specialists of Windesheims Digital Campus department when developing new dashboards.

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Appendix A

Survey

Beste collega,

Deze vragenlijst gaat over het benutten van (geanonimiseerde) data van studenten over hoe zij jouw online lesmateriaal gebruiken èn ervaren. Het doel van het gebruik van die data is dat jij als docent input krijgt om als nodig het lesmateriaal in de digitale leeromgeving te verbeteren.

De vragenlijst is verspreid onder alle docenten van Windesheim, de informatie wordt samengevoegd en geanonimiseerd aangeboden aan de afdeling van Informatievoorziening en Technologie (IVT) van Windesheim, de resultaten zullen via het Sharenet zo spoedig mogelijk beschikbaar worden gemaakt. Tevens wordt de informatie benut voor het schrijven van een masterthesis.

De vragenlijst is alleen zinvol in te vullen door docenten die zelf het online lesmateriaal bij hun module/cursus verzorgen in de ELO, Rise, Xerte en/of Teams. De lijst bestaat uit maximaal 20 vragen.

Ben je werkzaam als docent?
0 Ja
0 Nee Eindscherm: "Hartelijk dank voor het willen reageren op deze vragenlijst, de vragen zijn echter geheel afgestemd op het werk en de taken van docenten, verder invullen heeft geen zin, sorry.
Je kan wel de vragenlijst inzien, klik dan hier."
Mocht je toch iets over dit onderwerp willen opmerken, zeer welkom:
_____

De vragenlijst wordt nu afgesloten.

Verzorg je zelf als docent de online lesmaterialen van je module of cursus in de ELO, in Rise, Xerte of Teams?
0 Ja
0 Nee Eindscherm: "Hartelijk dank voor het willen reageren op deze vragenlijst, de vragen zijn echter geheel afgestemd op docenten die online lesmateriaal verzorgen, verder invullen heeft geen zin, sorry.
Je kan wel de vragenlijst inzien, klik dan hier."
Mocht je toch iets over dit onderwerp willen opmerken, zeer welkom:
_____

De vragenlijst wordt nu afgesloten.

Neem één van jouw modules of cursussen waarvoor jij ook het online deel verzorgd in gedachten.

1. Is deze module of cursus bestemd voor
0 Voltijd-studenten?
0. Deeltijdstudenten of Leven Lang Ontwikkelen?
0 Anders ……

Onder online leeractiviteiten verstaan we taken die jij voor studenten in een digitale leeromgeving hebt gezet, waarmee zij leeruitkomsten kunnen verwerven en/of laten zien.

2. Waarin staan de online leeractiviteiten voor jouw module of cursus? Meerdere antwoorden mogelijk.
0 ELO
0 Rise
0 Xerte
0 Teams
0 Anders ……..

3. Welke online leeractiviteiten bied je aan in jouw module of cursus? Kruis ze alle aan.
0 Links naar pdf's met leesmateriaal.
0 Links naar video's op bijvoorbeeld YouTube.

0 Video in de leeromgeving zelf.
0 Open vragen met intyp-mogelijkheid-mogelijkheid.
0 Vragen met 1 antwoordmogelijkheid, die bij aanklikken zichtbaar wordt.
0 Formatieve quizvragen met meerdere antwoordmogelijkheden.
0 Formatieve inleveropdrachten (reflectieverslag, paper, opname, presentatie, werkstuk).
0 Module- of cursus-informatie, zoals studiewijzer, intro, toets-criteria etc.
0 Samenwerkingskanaal met opdrachten.
0 Online college met interactie.
0 Anders, nl. _____

Stel, je zou -om je lesmateriaal te verbeteren-, anoniem de data van je studenten kunnen krijgen over hoe zij dit lesmateriaal gebruiken en ervaren. **Wat precies zou je dan willen weten?**

4. Over een link naar de pdf met leesmateriaal:
0 Of de studenten op de link klikken.
0 Hoelang het duurt voor de studenten op een onderdeel buiten de pdf klikken.
0 Welke Pdf's het meest geopend zijn.
0 Welke Pdf's het minst geopend zijn.
0 Hoe zinvol de studenten het leesmateriaal vinden.
0 Of de studenten een technisch probleem met dit item hebben.
0 Anders, nl. _____

5. Over een link naar de video op bijvoorbeeld YouTube:
0 Of de studenten op de link voor de video klikken.
0 Hoelang het duurt voor de studenten op een onderdeel buiten de video klikken.
0 Welke links het minst aangeklikt worden.
0 Hoe zinvol de studenten de video vinden.
0 Of de studenten een technisch probleem met dit item hebben.
0 Anders, nl. _____

6. Over een link naar de video in de leeromgeving zelf:
0 Of de studenten de video starten.
0 Wat de laatste minuut is van de video die wordt afgespeeld.
0 Of de studenten de video pauzeren.
0 Hoe vaak de studenten de video starten.
0 Hoelang het duurt voor de studenten op een volgend onderdeel klikken.
0 Het aantal video's dat de studenten start.
0 Welke video het minst gestart wordt.
0 Hoeveel tijd de studenten besteden aan video's.
0 Hoe zinvol de studenten de video vinden.
0 Of de studenten een technisch probleem met dit item hebben.
0 Anders, nl. _____

7. Over open vragen met intyp-mogelijkheid:
0 Of de studenten überhaupt een antwoord intypen.
0 Of er bepaalde woorden voorkomen in het ingetypte antwoord.
0 Bij welke vragen er het minst iets ingetypt wordt.
0 Hoe zinvol de studenten de open vraag vinden.
0 Of de studenten een technisch probleem met dit item hebben.
0 Anders, nl. _____
8. Over vragen met 1 antwoordmogelijkheid (die bij aanklikken zichtbaar wordt):
0 Per vraag of de studenten het antwoord aanklikken om te openen.
0 Welke vragen het minst omgeklapt worden.
0 Over hoe zinvol de studenten de gestelde omklapvragen vinden.
0 Of de studenten een technisch probleem met dit item hebben.
0 Anders, nl. _____

9. Over (formatieve) quizvragen met meerdere antwoordmogelijkheden:
0 Per vraag of de studenten minimaal 1 antwoord aanklikken.
0 Per vraag hoeveel pogingen studenten doen.

0 Per vraag of de studenten minimaal 1 toelichting op het antwoord checken.
0 Per vraag: Welke vraag wordt het minst gemaakt.
0 Per quiz hoeveel tijd de studenten besteden.
0 Per quiz of de studenten alle vragen met minimaal 1 antwoord aanklikken.
0 Per quiz hoeveel antwoorden studenten goed hebben bij eerste poging.
0 per quiz welke quiz het minst gemaakt wordt.
0 Per vraag hoe zinvol de studenten deze vraag vinden.
0 Per quiz hoe zinvol de studenten deze quiz vinden.
0 Het aantal quizzen dat de studenten gebruikt.
0 Hoeveel tijd de studenten besteden aan alle quizzen samen.
0 Of de studenten een technisch probleem met dit item hebben.
0 Anders, nl. _____

10. Over formatieve individuele inlever-opdrachten (reflectieverslag, paper, opname, presentatie, werkstuk)
0 Wat in de reeks van inleveropdrachten wel en niet binnen is.
0 Per opdracht: Hoeveel tijd de studenten aangeven eraan gewerkt te hebben.
0 Per opdracht: Hoe zinvol de studenten de opdracht vinden
0 Of de studenten een technisch probleem met dit item hebben.
0 Anders, nl. _____

11. Online college met interactie
0 Per college aantal studenten dat live aanwezig is.
0 Per college hoeveel vragen er live of later worden gesteld.
0 Over collegereeks vergelijking aantal studenten dat live aanwezig is.
0 Over collegereeks vergelijking aantal minuten dat studenten live aanwezig zijn.
0 Anders, nl. _____

12. Docent-begeleid samenwerkingskanaal met formatieve opdrachten:
0 Per samenwerking aantal studenten dat inlogt op het kanaal.
0 Per samenwerking aantal minuten dat de activiteit op het kanaal duurt.
0 Per kanaal hoe vaak er opnieuw contact wordt gelegd.
0 Over de verschillende kanalen vergelijking hoeveel activiteit er is.
0 Anders, nl. _____

13. Onbegeleid samenwerkingskanaal met formatieve opdrachten:
0 Per samenwerking aantal studenten dat inlogt op het kanaal.
0 Per samenwerking aantal minuten dat de activiteit op het kanaal duurt.
0 Per samenwerking of er een bestand is geüpload.
0 Over de verschillende kanalen vergelijking hoeveel activiteit er is.
0 Anders, nl. _____

14. Zou je de data van verschillende leergangen met elkaar willen kunnen vergelijken?
0 Ja
0 Nee
Opmerking: _____

15. De zinvolheid van leeractiviteiten zou op verschillende manieren gevraagd kunnen worden:
"In hoeverre vond je dit deel zinvol om te doen?" Welke manier heeft jouw voorkeur?
0 Duimpje omhoog, duimpje omlaag per onderdeel.
0 Smiley's in stoplicht kleuren in een kantlijn-optie per onderdeel.
0 Een cijfer van 1 t/m 10, waarbij een 1 'niet zinvol' en een 10 'zeer zinvol' is per onderdeel.
0 Open reactiemogelijkheid per leeractiviteit met vermelding van: 'Je reactie wordt gebruikt om het lesmateriaal te verbeteren, je docent antwoordt hier niet op.'
0 Open reactiemogelijkheid per door jou gekozen cluster van leeractiviteiten met vermelding van: 'Je reactie wordt gebruikt om het lesmateriaal te verbeteren, je docent antwoordt hier niet op.'
0 Anders, nl. _____

16. Als je al data van je studenten benut, hoe lang doe je dat al?
0 Ik gebruik geen data van studenten
0 tot 1 jaar
0 1-2 jaar

0 2-3 jaar
0 3-4 jaar
0 Langer dan 4 jaar

17. Als je hier zo over nadenkt, zou je dan eigenlijk (meer) geanonimiseerde data van je studenten willen krijgen om je lesmateriaal te verbeteren?

Ja, want _____
Nee, want _____
Ik weet het niet, omdat _____

18. Vind je, dat jij als docent, de data van studenten -die ongezien gelogd wordt- mag gebruiken?
0 Ja, dit valt onder de grondslag dat je als hogeschool je taak van 'goed onderwijs verzorgen' moet kunnen uitvoeren.
0 Nee, de studenten moet gevraagd worden of we de data van hoe zij/hij de online leermaterialen gebruikt, mogen benutten. Daarmee heeft de studenten ook rechten later terug te komen op dit besluit, wijzigen etc.
0 nee, überhaupt niet, dat zou ik niet willen omdat _____

19. In welk domein ben je voor meer dan 50% van je aanstelling werkzaam?
0 Bewegen & Educatie
0 Gezondheidszorg & Welzijn
0 Techniek
0 Business, Media en Recht
0 Flevoland

20. Wat is je leeftijd?
0 21 - 30 jaar
0 31 - 40
0 41 - 50
0 51 - 60
0 61 - 70

21. Tot slot, vul graag in:
0 Man
0 Vrouw
0 Anders

Hartelijk dank voor het invullen! De resultaten van deze [name instituut] -brede survey zullen onder het kopje 'Anoniem datagebruik voor verbetering lesmateriaal' op het intranet gedeeld worden.

Wil jij meedenken over hoe we binnen [name instituut] data kunnen gebruiken om onze online leeractiviteiten te verbeteren? Ik maak graag een afspraak met je. Het kost je maximaal een uur van je tijd.

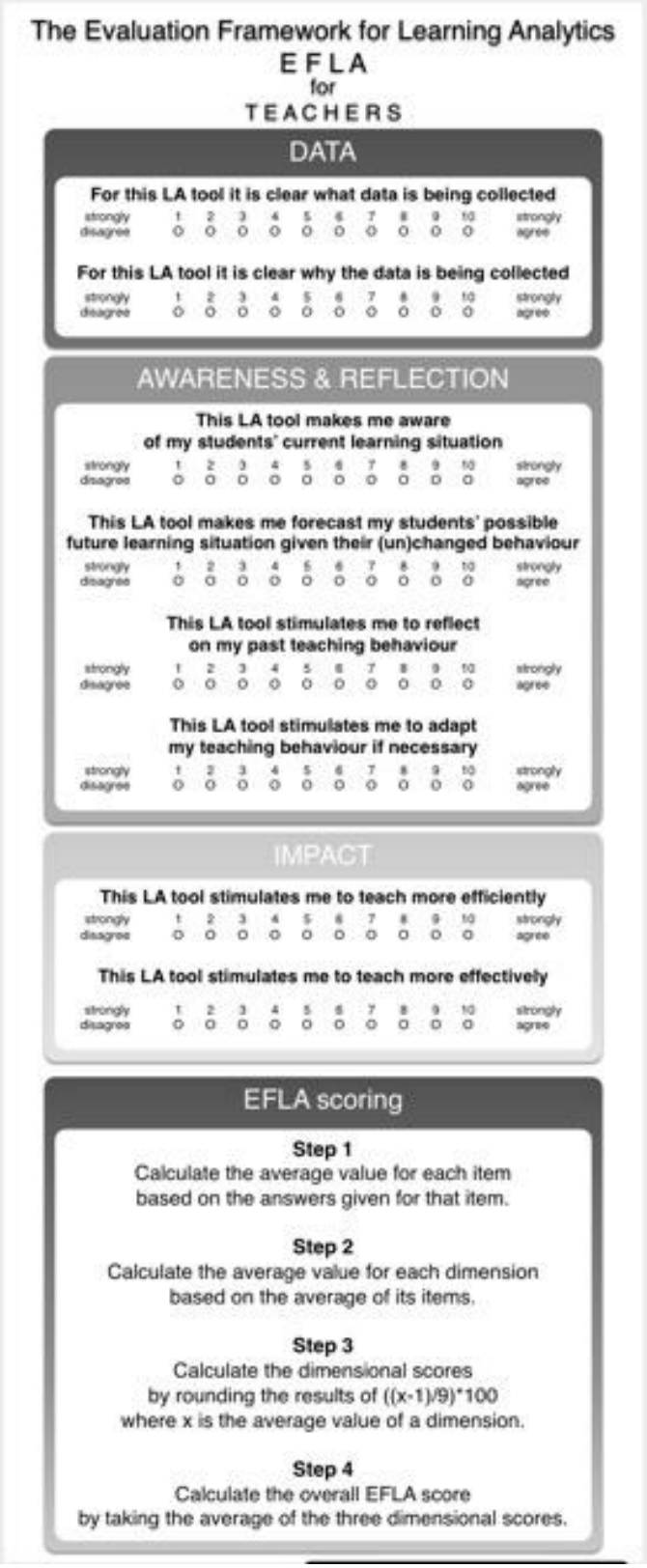
Vul hier je mailadres in _____ .
Dit adres zal enkel en alleen gebruikt worden om je te benaderen om mee te denken, het wordt op geen enkele wijze gekoppeld aan hetgeen je hierboven hebt ingevuld.

Met vriendelijke groet,

Lydia ten Den
lm.ten.den@windesheim.nl

Appendix B

Evaluation Framework Learning Analytics for Teachers



Appendix C

Results Survey: List of Indicators of All Learning Activities

Teachers' needs on four most used learning activities in full-time (FT) and Lifelong Learning (LLL) courses

Learning activities	Teachers' needs on information	FT	LLL
Reading texts[a]	**Whether students click on the link to the text**	**72%**	**68%**
	How long before students click on other activity	42%	42%
	Which links to texts are opened most	**68%**	**58%**
	How helpful students perceive the reading texts	**74%**	**79%**
	Which links to texts are least opened	51%	37%
	Whether there is a technical problem with this item	33%	37%
Videos YouTube[b]	**Whether students click on the link to the video**	**73%**	**65%**
	How long before students click on other activity	43%	29%
	The amount of video links clicked on	52%	29%
	Which links to videos least clicked on	46%	41%
	How helpful students perceive the video	**80%**	**71%**
	Whether there is a technical problem with this item	32%	29%
Formative assignments[c]	**How many assignments were handed in**	**71%**	**79%**
	Time students reported spent on the assignment	**67%**	50%
	How helpful students perceive the assignment	**64%**	**64%**
	Whether there is a technical problem with this item	26%	21%
Online lectures[d]	**Per lecture the number of attendees (synchronous)**	**79%**	**77%**
	How many questions are asked live or later	29%	24%
	Per lecture students' opinion on pace	**71%**	**59%**
	Per lecture students' opinion on length	**67%**	**71%**
	How helpful students perceive the lecture	**83%**	**82%**
	Per series the number of attendees compared	56%	53%
	Per series minutes attending compared	42%	53%
	Per series which lectures helpful	**60%**	**71%**
Embedded videos[e]	**Whether students start the video**	**77%**	**75%**
	How long before students stop the video	**68%**	**50%**
	How often students start the video	39%	33%
	How long before students click on other activity	42%	33%
	How helpful students perceive the video	**77%**	**58%**
	Whether there is a technical problem with this item	26%	42%
	The number of videos students start	36%	33%
	Which videos least started	48%	50%
Open questions[f]	**Whether students type in answer**	**80%**	**100%**
	Which specific words are typed in	53%	33%
	How helpful students perceive the questions	53%	**67%**
	Whether there is a technical problem with this item	20%	0%
	Which questions least answered	40%	0%

Multiple choice quiz[g]	Whether students click on at least one answer per question	35%	50%
	Whether students check the explanation per question	44%	100%
	Which question is answered least	30%	50%
	How helpful students perceive the question	39%	0%
	How much time students spent per quiz	**74%**	**100%**
	Whether students answer all questions per quiz	26%	50%
	How many answers are correct per quiz	**65%**	**100%**
	Which quiz is taken least	30%	50%
	How helpful students perceive the quiz	**61%**	50%
	Whether there is a technical problem with this item	30%	0%
	The number of quizzes taken	35%	0%
Flashcard questions[h]	**Whether students click on question to show answer**	**80%**	**100%**
	How helpful students perceive the question	40%	100%
	Whether there is a technical problem with this item	0%	100%
	Which questions are clicked on least	20%	0%
Guided collaboration[i]	**Number of students' log in on sub-group per session**	**61%**	**64%**
	How students perceive the collaboration session	**76%**	**73%**
	How students perceive the collaboration per sub-group	**88%**	**64%**
	Whether there is a technical problem collaborating	42%	55%
Unguided collaboration[j]	Number of students that log in on sub-group per session	54%	29%
	How long activity last per sub-group per session	62%	14%
	Which documents are opened per session	30%	29%
	How students perceive the collaboration per session	**69%**	43%
	Have students clarity on collaboration goals	**69%**	57%
	How students perceive the collaboration per sub-group	**85%**	**71%**
	Whether there is a technical problem collaborating	46%	29%

Note. This table shows s summary of most frequently marked teachers' needs on information on the four most frequently marked learning activities. Most mentioned needs are in bold face.

[a]n FT=57; LLL=19. [b]n FT=44; LLL=17. [c]n FT=42; LLL=14. [d]n FT= 48; LLL=17. [e]n FT=31; LLL=12. [f]n FT=15; LLL=3. [g]n FT=23; LLL=2. [h]n FT=5; LLL=1. [i]n FT=33; LLL=11. [j]n FT=26; LLL=7. n≤5 in grey face.

Appendix D

Dashboard Construction: Fabricated Students' Remarks and Reviews

Table C.1.

Students' Remarks in Answer on Question "How Helpful was this [Item] to you?"

Text 1	Text 2	Text 3	Text 4	Text 5	Text 6
moeilijk, ik mis overzicht	handig artikel (3x)	laatste blz mist (3x) stopt zo raar prima goed ik mis laatste stuk goed	moeilijk, ik mis overzicht niet (4x) ingewikkeld niet zo zinvol dit had ook wel korter gekund lastig pff	niet zo fijn stuk te moeilijk (3x) slecht lees-baar mag wel kor-ter gaat wel voegt niks toe lastig artikel	fijne voorbeel-den goed leesbaar fijn stuk (2x) wel wat saai
lastig te lezen (2x)	fijne voorbeel-den (2x)	koste meer tijd dan ik dacht zinvol (2x)			
waar gaat dit over	goed leesbaar handig (4x)				
slecht lees-baar (2x					

Video[a] 1	Video 2	Video 3	Video 4	Video 5
handig (4x) top duidelijker dan college	best zinvol (2x) ja, zinvol te lang (3x) fijn (2x)	voegt niks toe maakt het in-gewikkeld verwarrend (3x)	ik snap deze niet (2x) on duidelijk niet verstaan-baar verband met vorige?	handig goed lekker helder tof (3x) top!

Assigment[b] 1	Assigment 2	Assigment 3	Assigment 4
moeilijk (2x) niet zinvol (2x) geen idee wat ik aan het doen ben had eerst vi-deo moeten kijken lastig	niet (2x) dump hoe dan? lastig begin heftig weet niet hoe hoe begin ik?	veel pff goed te doen leuk te laat begon-nen niet (3x) veel werk	wel zinvol (3x) ik snap het nu wel goed te doen lastig veel werk voorbeeld? onduidelijk

Lecture 1	Lecture 2	Lecture 3	Lecture 4	Lecture 5	Lecture 6	Lecture 7	Lecture 8
heel zinvol moeilijk (4x) snapte het niet (3x) pittig	zinvol heel zinvol fijn meer voor-beelden meer voor-beelden	saai saai boring onduidelijk vaag	moeilijk! wil terugkijken goed goed top verhelderend	miste opname goed saai goed	saai zinvol ik snap het nu handig	goed had wel in coll. 1 gekund wou wel op-name wat moeilijk	saai saai te weinig uitleg niet
Lectures pace							
goed (3x) te hoog (7x)	te hoog (5x) goed (6x)	traag traag slow	goed goed beetje hoog	te hoog te hoog hoog maar goed	prima prima iets snel ok goed ok	ok ok goed goed	te laag te laag te laag te laag
Lectures duration							
goed te lang (6x) te moeilijk	goed te lang (3x) goed zo goed	goed te lang (3x)	meer voorbeel-den compacter goed te lang (3x)	goed (2x) te lang (2x) ok	goed (2x beetje lang was zo om	te kort (3x) goed	te lang (2x) way to lang overbodig

Note.

[a]Not included here information on all videos time spent.

[b]*Not included here information on all assignments self-reports on time spent.*

Dashboard Construction: Fabricated Information Under Comparison-Buttons

Table C.2.

Student Reviews Under Comparison-Buttons

Reading texts	How helpful[a] semester 20/21	How helpful[a] semester 19/20	Recommend[b] semester 20/21	Recommend[b] semester 19/20
Tekst 1 'Doelstellingen en hypotheses'	6 (7 reviews)	6 (12 reviews)	3x ja/7x nee	2x ja/6x nee
Tekst 2 'Herkennen van een onderzoeks-vraag'	8 (5 reviews)	7 (5 reviews)	14x ja/1x nee	5x ja/2x nee
Tekst 3 'Literatuur zoeken en vinden'	5 (4 reviews)	4 (4 reviews)	10x ja/3x nee	0x ja/6x nee
Tekst 4 'Onderzoek uitvoeren'	5 (4 reviews)	4 (4 reviews)	1x ja/7x nee	2x ja/6x nee
Tekst 5 'Kwantitatieve data verzamelen'	4 (3 reviews)	4 (3 reviews)	0x ja/7x nee	0x ja/5x nee
Tekst 6 'Kwalitatieve data verzamelen'	8 (6 reviews)	7 (6 reviews)	11x ja/1x nee	5x ja/1x nee
Videos				
Video 1 'Hoe doe je onderzoek'	8 (7 reviews)	7 (5 reviews)	11x ja/ 1x nee	6x ja/1x nee
Video 2 'Hoe formuleer je goede onder-zoeksvraag'	7 (5 reviews)	7 (4 reviews)	9x ja/ 1x nee	6x ja/1x nee
Video 3 'Hypothesises, the works'	5 (14 reviews)	6 (11 reviews)	1x ja/ 6x nee	2x ja/5x nee
Video 4 'How to prove everything'	4 (15 reviews)	3 (12 reviews)	0x ja/14x nee	0x ja/7x nee
Video 5 'Research step by step'	8 (12 reviews)	7 (13 reviews)	12x ja/ 1x nee	7x ja/1x nee
Assignments				
Opdracht 1 'Beschrijf een doelstellling'	5 (7 reviews)	6 (7 reviews)		
Opdracht 2 'Formuleer voorlopige onder-zoeksvraag'	4 (5 reviews)	5 (10 reviews)		
Opdracht 3 'Zoek 5 artikelen en vat samen'	7 (11 reviews)	7 (4 reviews)		
Opdracht 4 'Maak een plan van aanpak'	8 (9 reviews)	7 (6 reviews)		
Lectures				
College 1 'Intro onderzoeken'	7 (5 reviews)	6 (8 reviews)		
College 2 'Voorbeelden van onderzoek'	6 (4 reviews)	5 (5 reviews)		
College 3 'Onderzoeksvragen'	5 (11 reviews)	6 (9 reviews)		
College 4 'Hypotheses en verdelingen'	6 (5 reviews)	7 (8 reviews)		
College 5 'Kwantitatief onderzoek'	8 (4 reviews)	7 (5 reviews)		
College 6 'Kwalitatief onderzoek'	7 (10 reviews)	7 (9 reviews)		
College 7 'Literatuur selecteren'	6 (12 reviews)	8 (4 reviews)		
College 8 'Veelgemaakte fouten'	6 (6 reviews)	5 (7 reviews)		

Note.

[a]How helpful was this [item]to you? Score between 1 and 10.

[b]Would you recommend this [item] to a fellow student? Score between 1 and 10.

Appendix E

Interviews: Full List of Suggestions Made on Prototype 1

Suggestions In-Depth Information

- Add a hyperlink to each of the texts, videos, assignments, and PowerPoints of colleges.
- Add comparison to previous editions of course on semesters '19/20 sem. 2';'20/21 sem. 1'.
- Add comparison same course several departments.
- Add more information from which I can learn whether a reading text is effective e.g., Test results. Add a connection with the rate of return, dependent and independent variable.
- Add how long students watch the videos.
- Add how long students take to read the texts.
- Add how long students stay logged in on the lectures.
- Add a rating question on would you recommend this text/video/class to others?
- Add a rating question on how appealing was this video to you?
- Add a rating question to what extent do you think you master this subject?
- Add a rating question on whether the amount of LAC is too extensive.
- Add my baseline scan and the test results and I could see whether my LAC are effective.
- Add a free text question What suggestion do you have for the teacher when he teaches this subject again.
- Add cross connections: Are the students who read the same students who watch, hand in on time and attend lectures and pass the test back and forth.

Suggestions Technical

- Add purpose of the dashboard to the heading.
- Adjust text in 'Comparison'-button to 'Click here for comparison on rating'.
- Mark how many students made a certain remark, e.g., 3x.
- Add how many students rated, e.g., 5 reviews.
- Add the word 'hour' to remarks on how much time was used for assignment.
- Add word 'back' to blue arrow in the comparison windows'.
- Add the open questions (which students answered) on each block of remarks, e.g. 'How useful was this text/video/assignment/class to you?'
- Delete words 'before deadline' in the heading 'Number of students that submitted assignment into the ELO'.
- Unite header parts by using a light background colour.
- Enlarge font format in comparison-windows.
- Turn of 'filter heading' on all parts of the dashboard.
- Add explanation on remarks students' free text and number of students who made remarks.
- Add explanation on remarks students on how information was collected: Remarks made by students who opened texts.
- Add a hint 'Hoover over bars for remarks students'.
- Add more distinct colouring to the bar charts.
- Percentages instead of absolute numbers on how many students clicked on pdf, video, assignments, or attended class that would help comparison between semesters.
- Hoovering on bars showing information on subject e.g., title of reading text or video
- Numbers in lower part of bars instead of legend
- Bars separated from each other.
- How long students stay at texts.
- Filter Fail or Pass on comparisons all 4 LACs.

Interviews: Full List of Suggestions Made on Prototype 2

Suggestions In-Depth Information

- Add a bar chart of used time on reading texts.
- Add how many students watched recordings lectures and how many minutes.
- Add feedback question at lectures on opinions teacher expertise (content knowledge and practice).
- Ask students to commend on what works and does not work for them in lectures.
- Relate student efforts to their remarks and grades to be able to weigh remarks.
- Add a self-assessment question (Likert scale) on understanding subject.
- Add question as 'To what extent does this text/video/lecture add to you becoming a professional?'
- Add a question as "To what extent do you agree that this text/video/assignment/lecture is important to you becoming a professional?'
- Add a question for an overall grade for the course: 'To what extent does this course help to become a better professional?'
- Add a function to be able to filter on grades (6,7,8's) with large student numbers.
- Add a function to be able to mediate grades to filter outliers (with large student numbers).
- Connect LAC so you can see what efforts students did before starting an assignment.

Suggestions Technical

- Display 'fail' and 'pass' in one screen by colouring in red and green with a filter 'neutral' or 'grades'.
- Use percentages in comparisons; use bar charts on reviews.
- Access comparisons through free text remark boxes instead of separate buttons
- Use a larger font for dashboard purpose or place purpose above title.
- Add the word 'formative' to the assignments heading.
- Add more colouring discrimination in the graphs.
- Add more space between graphs or split with lines.
- Use another colour for ELO-graphs than Teams graphs.
- Four graphs in one screen is a bit much, 2 x 2 might work better
- Add a clue that hoovering on a bar uncovers more information.
- Add in each bar the number of free texts reviews.
- Add explanation that remarks are free text.
- Use a larger or bold font for video length.
- Revert axes in length video graph.
- Improve lay out comparisons, headings and spacing.
- Replace 'Chose test results' with 'Filter test results'.
- Accentuate which filter is chosen.
- Rewrite the first paragraph in the 'help' page; add that some students gave just a grade, others added text to grade. Add a screenshot what students see on their screens. Add in the guide page that 'video-length watched' includes play time after pause-button is used.
- Add 'Click here for 'contact details' to 'I' in bottom left corner.

Appendix F

Interviews: Questions & Remarks Made on Prototype 1 and Prototype 2

In all interviews, interviewees raised issues not directly related to the aim of this research, but appropriate to its context. Some of the issues summarized are here:

- A warning was given for an overload on feedback questions for students which could lead to the effect that students would stop responding.
- A pitfall is foreseen in that the dashboard shows data of participating students and leaves a gap of information from those students who do not leave data.
- The underlying assumption that students are capable of judging their own learning process was partly questioned.
- On effectivity: one interviewee emphasized that just short-term effectivity is measured in the school system, long term effectivity is not.
- On implementation: one interviewee predicted that teachers would keep expanding their wishes on information, so the dashboard would need continuous improvement.
- Opportunities were seen to integrate use of Forms, pre- and post-scans, Mentimeter, Peergrade into the dashboard.
- A suggestion was made to add a feature to compare on the same course over all departments and teachers.
- A concern was expressed whether managers would use the dashboard to judge teachers instead of using it for their support.
- A concern was expressed that this dashboard might be a bit much for a lot of teachers.
- On implementation: It should be actively distributed to teachers or used on team meetings, do not expect them to find it themselves.
- This dashboard would be convenient in exchanging information between teacher and educational board, curriculum board etcetera.
- A suggestion was done by three interviewees to develop a dashboard for students so they can monitor their (behaviour) in their learning process.